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THE DESCRIPTION and vſe of the Sphære

Deuided into three principal
Partes:

WHEREOF

The firſt intreateth eſpecially of the
circles of the vppermoſt moueable Sphære,
and of the manifould vſes of euery
one of them ſeuerally:

The ſecond ſheweth the plentifull
Vſe of the vppermoſt Sphære, and
of the circles therof ioyntly:

The third conteyneth the Deſcrip-
tion of the Orbes whereof the Sphæres
of the ſunne and moone haue beene
ſuppoſed to be made, with their
motions and vſes.

By EDWARD WRIGHT.

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ſet downe in the Table.

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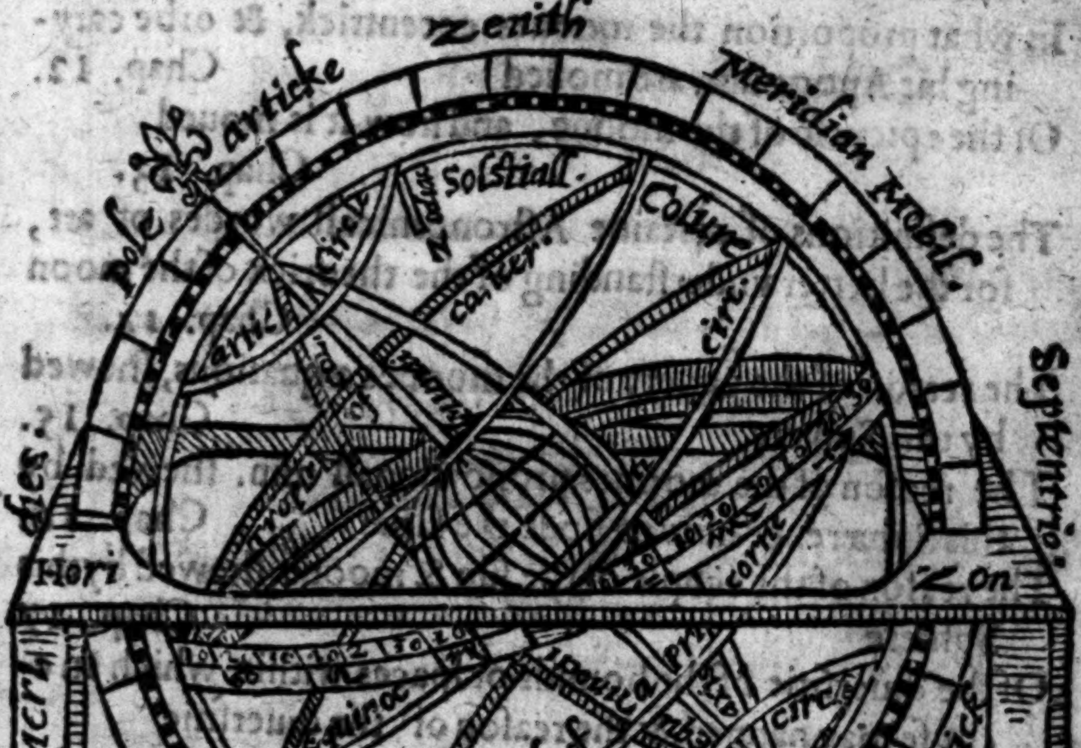
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The Deſcription of the SPHÆRE and GLOBE, Divided into three principall parts.

VVherof this firſt intreateth ſpecially of the circles of the vppermoſt moueable Sphære and of theyr peculiar vſes.

The definition & diuiſion of this Sphære.

CHAP. 1.

THis SPHÆRE, is nothing elſe but a repreſentation of the Cœleſtiall orbes and circles, that haue bene imagined for the eaſier vnderſtanding, expreſſing, & counting of the motions and apparences, eyther common to the whole heauens, or proper to the Sunne and Moone.

The circles of this Sphære are eyther immoueable, as the two greateſt and vtmoſt circles, the Horizon and Meridian, (whereto is adioyned the little howre circle that is fixed to the Meridian) or els moueable; as all the reſt conteyned within theſe.

The Deſcription of the Horizon of this Sphare.

CHAP. 2.

THE greateſt and vtmoſt circle of this ſphære that lyeth leuell on all ſides from the ground, is called the Horizon, which is deuided into 7. limbs, or borders. The firſt and vtmoſt of them conteyneth the 32. points of the compaſſe, or the windes (as they are at this day deuided and vſed by ſea-men) with their latine names adioyned vnto them. The ſecond limb conteyneth the names & diuiſions of the 12. windes as they were wont to bee deuided in ould time. The third is deuided into the moneths and dayes of the new Kalendar, firſt eſtabliſhed by Pope Gregory the XIII. & now vſed in many places beyond the ſeas. In the fourth limbe are ſet downe the moneths and dayes of the ordinarie Kalendar vſed in England. Next within this, are placed the 12. ſignes & degrees of the Zodiack, that ſo the place of the Sunne might be preſently knowne for any day of the yeare giuen, or contrariwiſe that the day of the moneth might be readily found by the place of the Sunne. After this, followeth the ſixt limb conteyning the 32. windes or points of the compaſſe, with letters repreſenting the names now in vſe amongſt Engliſh mariners. The ſeauenth & laſt limb next the innermoſt edge of the Horizon, is deuided into 360. degrees with figures ſet to euery tenth degree, beginning from the points of eaſt and weſt, & ending at north and ſouth, that ſo the number of any degree of the Horizon might be the eaſelier knowne: Which circle appeareth moſt playnly to them that are in a playne Champion countrie, or vpon the ſea cloſe by the water in a cleare calme day.

The vſes of the Horizon.

CHAP. 3.

1. IT deuideth the vpper and viſible part of the heauens from the nether halfe that is hidden out of our ſight.

2. It ſheweth partly the difference of a right & oblique Sphære, for when this circle and the equinoctial, croſſe each other at right angles, it is ſaid to be a right Sphære; otherwiſe when they make oblique angles one with another, it is called an oblique Sphære.

3. In an oblique Sphære this circle ſeuereth thoſe ſtarres which neuer riſe nor ſett, but are alwayes eyther aboue or beneath the Horizon, from ſuch ſtarres as riſe and ſet in euery 24 howres. For all the northerly ſtarres that are no further diſtant from the north pole then the north pole is from the Horizon, do neuer ſet, but are alwayes aboue the Horizon: And contrariwiſe, thoſe ſtarres that be about the ſouth pole, no further diſtant from it then it is from the Horizon, do neuer riſe, but are alwayes hidden out of ſight vnder the Horizon.

4. In reſpect of this circle the Sunne, Moone & ſtarres, or any other part or point of the heauens, are ſayd to riſe or ſet: For when they come vp from vnder the Horizon, they are ſaid to riſe; otherwiſe

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when they goe from aboue the Horizon downe vnderneath the ſame, they are ſayd to ſett.

5. And hereof it commeth that the aſcendent, & deſcendent are found by this circle: for that part of the eclipt ick that is at the eaſt part of the Horizon ariſing, is the Aſcendent; & the point oppoſite to this at the Weſt part of the Horizon, may be called the Deſcendent.

6. This circle partly ſheweth the difference of aſcenſion of any part or point of the heauens.

7. In this circle we reckon how farre the Sunne, the Moone, or any ſtarre, or point of heauen, ariſeth from the point of due Eaſt.

8. The horizon determineth the time of the artificiall day & night: for we call the time wherin the Sun abideth aboue the Horizon, an artificiall day: And the time that he continueth vnder the Horizon, is the artificiall night.

9. This circle ſheweth the reaſon of the æqualitie of artificiall dayes and nights, in a right Sphære: and of the inæqualitie of them in an oblique Sphære. For in a right Sphære, the Horizon deuideth all the paralels of the Sunne or circles of the naturall dayes, into æquall parts: But in an oblique Sphære, it deuideth them into vnæquall parts.

10. By meanes of this circle, we knowe what ſtarres, and what eclipſes, coniunctions, or other aſpects of the planets may be ſeene in our hemiſphære at any time.

11. From the horizon is meaſured the twilight: For in the morning the ſunne being vnder the horizon about 18. degrees of the vertical circle, the

twilight beginneth: And when the ſunne is ſo much vnder the horizon at euening, the twilight endeth.

12. This circle is of eſpeciall vſe in Geography, for from it we beginne to account the eleuation of the pole, and of the æquinoctiall circle, whereby the latitude of any place is knowne.

13. In Aſtrologie for erecting a figure, this circle ſheweth the beginuing of the firſt and ſeauenth houſes.

The deſcription of the Meridian of this Sphære.

CHAP. 4.

NExt the horizon, ſucceeds the Meridian ſtanding vpright on edge, & croſſing the horizon at right angles in the points of North and ſouth. This circle is deuided on both ſides at the inner edg into 360. degrees, with figures ſet to euery tenth degree, beginning at the æquinoctiall, & ending at the poles with 90. and beginning alſo at the poles, & ending at the æquinoctial with 90. The numbers beginning at the pole, ſerue to ſet the ſphære readily to any eleuation deſired. The other numbers beginning at the æquinoctiall, ſhew preſently, the declination of any degree of the zodiack, or of any point aſſigned in the ſphære. One quarter of the Meridian on eyther ſide thereof from the æquinoctiall to both poles, ſheweth the climates, and the quantities of the longeſt dayes.

The vſes of the Meridian.

Chap. 5.

1. It deuideth the world into two halfes or hemiſphæres: that is the Eaſt and the Weſt hemiſphæres. The eaſterly hemiſphære is all that part of the worlde which is on the Eaſt ſide of the Meridian, And the other halfe may be called the Weſt hemiſphære.

2. It ſheweth the North and ſouth parts of the worlde, for the two interſections of the Meridian with the horizon, ſhew the very points of North & ſouth. The ſouth point is that which is directly vnder the Sunne at noone: And the point right ouer againſt this, is called the North point.

3. It deuideth the arches of the æquinoctial, & of al his paralels, into two æquall parts both aboue and beneath the horizon.

4. And therefore it deuideth the artificial day and night into two æquall parts.

5. And conſequntly, it ſheweth midday and midnight.

6. In an oblique ſphære it ſerueth in ſtead of a right horizon (that is) an horizon that maketh right angles with the æquinoctiall.

7. Therefore the Aſtronomers beginne their account of times (which are meaſured by the æqua[illegible]tion of the æquinoctial) from the Meridian: the principal of which times, is the naturall day which is vſually begunne from midday, or midnight.

8. This circle ſheweth the higheſt and loweſt

heights of the ſunne and ſtarres, which is moſt manifeſt in thoſe ſtarres that are alwayes aboue the horizon. Theſe heights are called the Meridian altitudes of the ſunne or ſtars, which heights are chiefely obſerued by Aſtronomers and Nauigators with great diligence.

9. In this circle, we obſerue the diſtance of the Tropickes, and the greateſt obliquity of the Zodiack.

10. In this circle, we obſerue and count the latitudes of places, the height of the pole, & of the æquinoctial. For the height of the pole or æquinoctial, is nothing els but the arch of the Meridian conteyned betweene the pole or æquinoctial and the horizon. The height of the pole is alwayes æqual to the latitude of the place. The height of the æquinoctial is æqual to the complement of the latitude, and therefore it being ſubſtracted out of 90: there ſhall remayne the height of the pole.

11. The Meridian ſheweth the longitudes of places in Geographie.

12. In the Meridian, are meaſured the bredth of the zones and Climats.

13. This circle in Aſtrologie, ſheweth the higheſt & loweſt parts of heauen, which are the beginnings of two principal howſes: that is the fourth and the tenth howſes.

The deſcription of the howre circle, and poles, of this Sphære.

CHAP. 6.

THE little circle faſtned to the Meridian, is called the howre circle, which is deuided into 24. æqual parts, ſignifiyng and repreſenting vnto vs ſo many æqual howrs, wherof both the twelfth howrs are fixed iuſt vpon the Meridian, becauſe when the ſunne commeth to the meridian, it is iuſt twelue a clock: the vpper XII. ſerueth for the day; and the other XII. beneath ſerueth for the night.

The index, or the pointer in forme of an arrow, faſtned vpon the pinne that commeth through the midſt and center of this circle, is made to ſhew and point out the ſayd howres as neede ſhall require, in the vſe of the ſphære.

The vſe of this howre circle ſhal be ſhewed hereafter when we ſhal ſpeake of the common vſe of many circles of the ſphære togither. And theſe two circles (that is, the Meridian and horizon) are called immoueable, becauſe they keep themſelues alwaies, and in all places ouer the ſame parts of the earth; where as all the reſt (conteyned within theſe two) moue round about altogither with one motion in the ſpace of fowre and twentie howres.

This motion (being common to the whole heauens) is made about two points or poles, repreſented in this ſphære, by the two wyre pinnes about which the ſphære is turned; whereof the one that commeth through the middeſt of the little circle faſtned to the meridian (which we call the howre circle)

circle) repreſenteth vnto vs the pole arctick or the north pole: the other becauſe it is oppoſite to this, is called the antarctic pole, that is the right oppoſit, to, or right ouer againſt the north pole, which is alſo the ſouth pole.

Of the Aequinoctial circle of this ſphære.

CHAP. 7.

THAT circle which compaſſeth about the midſt of the ſphære, and is euery where of æquall diſtaunce from both poles, is called the æquinoctiall circle, or the æquator; eyther becauſe it is æqually diſtant from both poles of the world; or els becauſe the ſun comming vnder this circle maketh æqualitie of dayes and nights through-out the world.

Why this circle is called the æquinoctial or æquator.

It is deuided at the vtmoſt edge, on both ſides thereof into 360. degrees, with figures ſet to euery tenth degree, beginning at the beginning of Aries, and proceeding eaſtwards, til you be come about to the ſame point againe.

This circle hath many vſes.

1. It is the meaſure of the firſt motion. For this only amongſt al the circles of the ſphære is moued æqually both in a right & oblique ſphære, becauſe it alone being perpendicular to the axtree of the world, about which the ſphære is æqually turned, is deuided into two halfes by euery horizon in the ſame points.

2. It is the meaſure of time; becauſe it meaſureth the quantitie of the artificial & natural dayes, of which moneths and yeares are made: It meaſureth alſo the quantity of howres and of other times

which the ſunne maketh going vnder the zodiack. And therefore the degrees of the æquinoctial are called *tempora* (that is) times.

3. It ſheweth the two æquinoctial points in the ecliptick, cutting the ecliptick in two places, which are the beginnings of Aries and Libra: and the ſunne when he commeth to thoſe two points, is æqually diſtant from both poles of the world, and maketh æquality of dayes and nights in all places; which hapneth in our time about the 10. or 11. day of March, and the 13. or 14. of September.

4. The irregularity of the zodiack, and of all the ſignes and degrees therof, is meaſured by this circle. For ſeeing the moſt part of the apparences of the firſt motiō are referred to the zodiack, which is not turned about his owne poles, but about the poles of the ſphære, and therefore muſt needes be vnæqually turned about; it was needful that this inæquality ſhould be ruled and meaſured by ſome other æqual motion.

5. It deuideth the ſphære into 2. halfs (which they call hemiſphæres) that is into the north half or hemiſphære, wherein is the north pole, and into the ſouth hemiſphære, wherein is the ſouth pole.

6. So it deuideth the zodiack into the north half, and the ſouth half; or into the north ſignes, & the ſouth ſignes.

7. From this circle are numbred the declinations of the ſtarres, and of the degrees and partes of the ecliptick, and of any other point of Heauen.

8. And in this circle are counted the right aſcen-

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cenſions of the ſame degrees and ſtarres &c. For the right aſcenſion of any ſtarre or point of the heauens, is nothing els but the arch of the æquinoctial circle conteyned betweene the beginning of Aries and the Meridian, the ſame ſtarre or point being firſt brought vnder the Meridian.

9. In the æquinoctiall is counted the aſcentional difference and the oblique aſcenſion & deſcenſion of any point of heauen. And from the ſame circle is rekoned the diſtance of the ſunne riſing from the true eaſt point. For the oblique aſcenſion or deſcenſion is nothing els but the arch of the æquinoctial, conteyned betweene the beginning of Aries, and that point of the æquinoctial eaſtwards, which ariſeth or ſetteth together with the ſtarre or point that is giuen, in an oblique ſphære. And the difference aſcenſional or deſcenſional is nought els but the arch of the æquator, whereby the right & oblique aſcenſion or deſcenſion of a ſtarre, or any other point in heauen do differ each from other. The diſtance of the ſunnes riſing frō the true Eaſt point (which in latine is called *amplitudo ortiua*) is the arch of the horizon conteyned betweene the æquinoctial and the parallel of the ſunne, or his center when he riſeth.

10. In Geographie we count the longitudes of places in this circle; and from it we reckon the latitudes, in the globe of the earth, and in maps, & ſea charts. For the longitude of a place is nothing els but the arch of the æquinoctial circle conteined betwe̊ne two meridians, whereof one goeth by the Canarie Ilands, and the other by the place that is

giuen,

giuen. And the latitude of a place is the arch of a meridian conteyned betweene the æquinoctial, & the zenith of the place that was giuen.

11. In dialling this cirle is of eſpecial vſe. For by meanes of it the ſpaces of the howres are deuided in all kindes of dialls, horizontal, erect, direct, declining, inclining, reclining, &c.

12. In Aſtrologie the twelue houſes are ſet out by the æqual diuiſions of this circle into twelue parts, according to the waye deuiſed by *Regiomontanus*, which way is commonly called rational or reaſonable. And this circle gouerneth the directions, whereby things to come are artificially foretould.

The deſcription of the zodiack of this ſphære.

CHAP. 8.

THe great broad circle that compaſſeth about the ſphære obliquely, comming nearer the pole of the ſphære in one place then in another, is called the zodiack.

Round about through the midſt of this circle, is drawne the circumference commonly called the ecliptick line, diuiding the whole ſphære, and the whole bredth of the zodiack throughout, into two æquall parts.

In this ſphære there are repreſented vnto vs two ecliptick lines. The one may be called the middle, or fixed ecliptick, which keepeth alwayes the ſame diſtance or obliquitie from the æquinoctial. The other may be called the true or moueable ecliptick, be-

becauſe it maketh not alwayes the ſame angles of interſection with the æquator, but ſometimes greater, ſometimes leſſe. For the greateſt obliquity of the zodiack, which not long before *Ptolomees* time was obſerued to be 23. degrees and 52. min. in *Copernicus* his time, was hardly found to exceed 23. degrees 28 min. according to his obſeruation, and therefore he thought that the difference betweene the greateſt and leaſt obliquitie of the zodiack, was 24. minutes: and the middle or meane obliquitie between both theſe, to be 23. degrees 40 minutes.

The manner of the variation of this obliquitie may in ſome ſort be ſhewed by this ſphære, if we ſuppoſe the fixed ecliptick drawne round about through the midſt of the zodiack to be 23 degrees 40 minut, diſtant from the æquinoctial at the beginning of Cancer and Capricorne: and the moueable ecliptick (faſtned as it were vpon two poles at the beginning of Aries and Libra, and ſo hauing alwaies the ſame points of interſection with the middle ecliptick and æquinoctial) to be moued vp and downe aboue and beneath the middle ecliptick, by the ſpace of 12. minutes at the beginning of Cancer and Capricorne: and this motion to finiſh his reuolution once in 3432 Iulian yeares.

The bredth of the zodiack is bounded by the greateſt latitudes of the planetes, eſpecially of Venus and Mars, which ſometimes hath almoſt 7 degrees of latitude.

The zodiack is deuided by the æquinoctial into two ſemicircles.

The one aboue the æquinoctial is called the northerly ſemicircle: the other half beneath the æquinoctial is the ſouthern ſemicircle of the zodiak.

So long as the ſunne moueth vnder the firſt of theſe ſemicircles, the dayes are longer then the nights, otherwiſe they are ſhorter.

Each of theſe ſemicircles is againe deuided into two parts, and ſo the whole zodiack into fowre quarters: the firſt from Aries to Cancer may be called the vernal or ſpring quarter, which in this Sphære is alſo ſhewed by the word *Ver* (ſignifiyng the ſpring:) The next from Cancer to Libra, the ſummer quarter, wherein is written the word *Aeſtas* ſignifiyng the ſummer. The 3. from Libra to Capricorne is the Harueſt quarter, wherin you ſhal finde in this ſphære the worde *Autumnus* which ſignifieth Autumne or Harueſt. The fourth and the laſt from the beginning of Capricorne to Aries is called the winter quarter, which in this ſphære is ſhewed by this worde *Hiems* which ſignifieth the winter. And theſe foure quarters of the zodiack are thus called by the names of the quarters of the yeare, becauſe the ſunne mouing vnder thoſe quarters of the zodiacke, maketh thoſe fowre quarters of the yeare. Euery one of theſe quarters of the zodiack is againe deuided into three parts, and ſo the whole compaſſe of the zodiack into 12. which are called the 12. ſignes, whereof euery one conteyneth 30. degrees in length from Weſt to Eaſt, & is in breadth æqual to the breadth of the zodiack. Theſe ſignes, &

the zodiack it ſelf haue theyr beginning from that common meeting, or croſſing of the eclipticK, and the æquinoctial, where the ecliptick beginneth to ariſe aboue the æquinoctial towardes the north pole: and they are called by theſe names; *Aries*, *Taurus*, *Gemini*, Cancer, *Leo* *Virgo*, *Libra*, *Scorpio*, *Sagittarie*, *Capricorne*, *Aquarie*, *Piſces*. That is to ſay, The Ramme, The Bull, The Twinnes, The Crabb, the Lion, the Virgin, the Ballance, the Scorpion, the Shooter, the Goate, the VVater-pourer, the Fiſhes. And they are ſignified by theſe characters ♈, ♉, ♊, ♋, ♌, ♍. ♎, ♏, ♐, ♑, ♒, ♓. This diuiſion of the zodiack into 12. ſignes and of euery ſigne into 30. degrees, nature it ſelfe ſeemeth to haue ſhewed by the motions of the ſunne and moone. For in what time the ſunne moueth once about the whole compaſſe of the zodiack, the moone maketh 12. reuolutions through the ſame. Therefore as the time of a yeare is deuided into twelue moones, ſo the zodiacke is deuided into twelue ſignes: And as euery moneth conteyneth 30. dayes, ſo euery ſigne is deuided into 30. parts, which they call degrees, which ſignifieth as much as ſteps, becauſe the Sun ſteppeth, or goeth forwards almoſt ſo much as a degree in euery day, from the VVeſt Eaſtwards vnder the Zodiack.

The Zodiack is otherwiſe alſo deuided into two ſemicircles, the one (from Capricorne to Cancer) aſcending, becauſe that ſo long as the ſunne or any of the plantes are in that ſemicircle, they ſtill aſcend and riſe higher and higher aboue the Horizon. The other ſemicircle of the zodiack, from Cancer to

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the zodiack it ſelf haue theyr beginning from that common meeting, or croſſing of the ecliptick, and the æquinoctial, where the ecliptick beginneth to ariſe aboue the æquinoctial towardes the north pole: and they are called by theſe names; *Aries, Taurus, Gemini,* Cancer, *Leo Virgo, Libra, Scorpio, Sagitrie, Capricorne, Aquarie, Piſces.* That is to ſay, The Ramme, The Bull, The Twinnes, The Crabb, the Lion, the Virgin, the Ballance, the Scorpion, the Shooter, the Goate, the VVater-pourer, the Fiſhes. And they are ſignified by theſe characters ♈, ♉, ♊, ♋, ♌, ♍, ♎, ♏, ♐, ♑, ♒, ♓. This diuiſion of the zodiack into 12. ſignes and of euery ſigne into 30. degrees, nature it ſelfe ſeemeth to haue ſhewed by the motions of the ſunne and moone. For in what time the ſunne moueth once about the whole compaſſe of the zodiack, the moone maketh 12. reuolutions through the ſame. Therefore as the time of a yeare is deuided into twelue moones, ſo the zodiacke is deuided into twelue ſignes: And as euery moneth conteyneth 30. dayes, ſo euery ſigne is deuided into 30. parts, which they call degrees, which ſignifieth as much as ſteps, becauſe the Sun ſteppeth, or goeth forwards almoſt ſo much as a degree in euery day, from the VVeſt Eaſtwards vnder the Zodiack.

The Zodiack is otherwiſe alſo deuided into two ſemicircles, the one (from Capricorne to Cancer) aſcending, becauſe that ſo long as the ſunne or any of the plantes are in that ſemicircle, they ſtill aſcend and riſe higher and higher aboue the Horizon. The other ſemicircle of the zodiack, from Cancer to

Capricorne, is called deſcending, becauſe the ſun or planetes being in that ſemicircle, come downe euery day lower then other.

The twelue ſignes are by the Aſtrologians diuerſely diuided, firſt into chiefe, meane, and common ſignes. The chief ſignes (which are alſo called Cardinall, that is the principal ſignes) are Aries, Cancer, Libra & Capricorne, becauſe they come next after the principal points of the zodiack that is the two æquinoctiall points at the beginnings of Aries, and Libra; and the two ſolſtitial points of Cancer and Capricorne. The meane ſignes (which are alſo called fixed) are Taurus, Leo, Scorpio, and Aquarius. They are called meane, becauſe they are placed betweene the chiefe or principall, and the common ſignes. They are called fixed ſignes, becauſe that when the ſun is in thoſe ſignes, we finde a more perfect temperature of the aire, then when he is in the other ſignes.

The common ſignes (which are alſo called double bodyed) are Gemini, Virgo, Sagittarie, and Piſces. They are called common, becauſe they take part of the nature of the fixed ſignes going before them, & of the Cardinal ſignes following after thē. They are called double bodied, by reaſon of theyr images, as they are imagined in the eight ſphære, which are compounded of two bodies: For there be two twinnes; and the virgin houldeth an eare of corne in her hand; Sagittarie is made of a man and an horſe; and there are two fiſhes. The placing, and nature of theſe ſignes brought in this diuiſion.

The Aſtrologians alſo deuide the twelue ſignes into fowre trigons or triplicities, ſo called becauſe they are diſtant the third part of a circle, one from another. The firſt triplicity contayneth Aries, Leo, and Sagittarius; & is called the fierye trigon, or triplicity: The ſecond triplicitie conteyneth Taurus, Virgo, and Capricorne; and is called the earthly trigon. The third triplicity conteyneth Gemini Libra and Aquarius; & is called the ayrie trigon. The fourth triplicitie conteyning, Cancer, Scorpio, & Piſces; is called the watrie trigon. Nature it ſelf is the cauſe of this diuiſion of the ſignes alſo. For into theſe trigons of the ſignes ſhe hath diſtributed the coniunctions of the three ſuperiour planets: eſpecially the coniunctions of Saturne and Iupiter, which the Aſtrologians cal great coniunctions. For examples ſake, if there be a great coniunction in Aries, the ſame ſhal be twenty yeares after in Sagittarie, and other twenty yeares after in Leo; & after as many more yeares, it returneth againe into Aries. The reuolution of one trigon conteyneth almoſt 200. yeares, after which time the ſame great coniunctions remoue into the next trigon.

The vſes of the zodiack.

Chap. 9.

1. THE zodiack is the meaſure of the ſecond motions, as the æquinoctiall is the meaſure of the firſt motion.

2. For in this circle we reckon the longitudes, and from it we count the latitudes of al the ſtarres. For the longitude of a ſtarre is nothing els but the arch of the ecliptick conteyned betweene the begin-

ginning of Aries, and the circle of the ſtarres latitude. And the latitude is the Arch of a great circle, drawne by the poles of the ecliptyck, conteyned betweene the ſtarre, and the ecliptick.

3. According to this circle, the whole Heauen, yea the whole world is deuided into twelue ſignes. Whereof it commeth that becauſe of this circle, aſwell the fixed, as the wandring ſtarres which we cal planetes, yea and thoſe ſtarres alſo that appeare of a ſuddaine, as blaſing ſtarres or comets, and other meteors, are ſayd to be in this or that ſigne; and that three manner of wayes.

First to be in a ſigne is to be vnder ſome one of the 12. parts of the ecliptick. Thus the ſtarres which are vnder the ecliptick, but eſpecially the ſunne which runneth always vnder it, are ſayd to be in the ſignes.

Secondly becauſe the zodiack hath latitude, thoſe ſtarres are ſayd to be in a ſigne, which although they be beſide the Ecliptick, yet are vnder the zodiack, and ſo any of the other planets, which for the moſt part wander beſide the ecliptick, may be ſayd to be in ſome ſigne.

Thirdly, if we vnderſtand ſix great circles to be drawne by the beginnings of the twelue ſignes, and by the poles of the ecliptick; by theſe circles the whole heauen (or rather the whole world) is deuided into twelue parts, which with a general name are called ſignes: Thus all the ſtarres aſwel fixed as planets and comets, which are without the zodiack in any of theſe parts, may be ſayd to be in ſome ſigne.

4. In this circle are noted the degrees of the

ſignes, with which the ſtarres do riſe & ſet, as well in a right as in an oblique ſphære. For becauſe this circle is the chiefeſt, all cæleſtial apparences (or at leaſt the moſt part of them) are referred vnto it, & not vnto the æquinoctiall. But the æquinoctiall meaſureth the times of their riſings and ſettings.

5. The obliquitie of the ecliptick is the cauſe of the inæqualitie, aſwell of naturall dayes in both Sphæres, as of artificial days in an oblique ſphære. For ſeeing it is moued vnæqually becauſe it is moued vpon other poles then his owne, the Sun which is the author, and maker of times mouing vnder it, muſt needes make vnæquall dayes.

6. The chiefe times are defined by this circle, as the time of a yeare, by the motion of the Sunne; the time of a moneth by the motion of the Moone, through the whole compaſſe of this circle. Alſo the 4. quarters of the yeare, Spring, Sommer, Autumne, and Winter; whereto may be added *Plato* his great yeare, which is the time wherin the fixed ſtarres make one reuolution about the axtree and poles of the zodiack, if God would haue the world to laſt ſo long.

7. The Eclipticke line ſheweth the places, and times of the Eclipſes: For the Sunne and Moone, are Eclipſed onely vnder it, or neare vnto it.

8. As the deſcription of the Tropickes dependeth on the obliquitie of the Ecliptycke, ſo the polar circles are deſcribed by the poles thereof.

9. Hereof it commeth, that by reaſon of the

ſame obliquitie, the zones & climates are ſet forth and bounded.

10. This circle is of eſpecial vſe in Aſtrologie, for it diſtinguiſheth the points of the 12. howſes, and in it the aſpects and configurations of the planets are obſerued: The chiefeſt iudgement aſwel in caſting figures as in reuolutions and directions is taken from this circle.

The deſcription of the two Colures, togither with the vſes common to them both.

CHAP. 10.

THE two circles croſſing each other at right angles in the poles of the Sphære, are called the Colures: whereof the one that paſſeth by the common meeting of the Ecliptick and æquinoctiall, is called *Colurus æquinoctiorum*, that is the æquinoctial colure, or the colure of æqual dayes & nights. The other paſſing by the poles of the ecliptyck, and the Solſtitial points, is called *Colurus ſolſtitiorum*, the Solſtitiall colure, or colure of the Sunne-ſtandinges.

Vſes common to both colures.

1. By meanes of theſe two colures, all the mouable circles of the materiall ſphære are framed togither, that ſo they might be turned about, like as the whole heauens are moued.

2. The poles are faſtned in the common meeting of theſe two circles: and the poles are alſo ſhewed by the ſame common meetings.

3. They ſhew the 4 principal points of the Ecliptick; that is, the two æquinoctial, & the two Solſtitial points.

4. Theſe circles ſhew thoſe pointes of the Ecliptick, wherin the ſunne is eyther æqually diſtant from both poles of the ſphære, or commeth neareſt to eyther of them: In which pointes the Sunne maketh the dayes longeſt or ſhorteſt, or of a meane length betweene both theſe in an oblique ſphære.

5. They deuide the Ecliptick into 4. quarters, in which the ſunne maketh fowre quarters of the yeare, the Spring, the Summer, Autumne, and Winter.

6. They deuide the Ecliptick & æquinoctial into ſuch fowre quarters, as in a right ſphære doe riſe togither in æqual time.

Vſes of the Æquinoctiall Colure.

Chap. 11.

1. THe ſection of this circle with the ecliptické, ſheweth the æquinoctial points, wherin the æquinoctial & the ecliptick do deuide and croſſe each other. In which points the ſunne maketh æquality of dayes and nights throughout the whole world: whereof this circle is alſo called *Colurus Æquinoctiorum*; that, is the colure of æqual dayes and nights, or the æquinoctiall colure.

2. It deuideth the Ecliptick into the north and ſouth halfes.

3. It deuideth the ſignes wherein the ſunne maketh the days longer then the nights, from thoſe ſignes wherein the dayes are made ſhorter then the nights.

4. It ſheweth which halfes of the Ecliptick and æquator, do riſe together in æqual time in an oblique ſphære.

5. It ſheweth the two high ſunn-ſtandings in a right ſphære, in the time of which ſun-ſtandings, the ſun paſſeth by the zenith.

Vſes of the Solſtitial Colure.

CHAP. 12.

1. THE common meetings of this circle with the ecliptick, ſhew the ſolſtitial or tropical points; in which points the ſunne ſeemeth to ſtand, and then returneth back againe: for which cauſe this circle is called the Colure of the ſun-ſtandings. Theſe points are called tropical (which is as much to ſay as turne-points, or points of returne) becauſe that when the ſunne going alwayes vnder the Ecliptick commeth to theſe points, which are furtheſt diſtant from the æquinoctiall circle, it returneth againe towards the ſame circle. But they were called Solſtitial or Sun-ſtanding points, becauſe that whileſt the Sunne is about thoſe points, the difference of the ſunnes returning is (for certayne dayes) inſenſible. Hereof the ſunne is ſaid to make his ſtation, or to ſtand, when he commeth to eyther of thoſe points. They that dwell without

the tropicks, haue two ſunneſtandings, that is the ſummer ſunnſtanding, or high ſunſtanding (when the ſun in ſummer time is at the higheſt, & next vnto our zenith being in the beginning of Cancer) and the winterly, or low ſunſtanding, when the ſun in winter time is loweſt in the Meridian, and fartheſt from our zenith. But they that dwell within the tropickes (by a certayne ſimilitude taken from our ſunſtandings, wherein the ſunne is eyther higheſt or loweſt) are ſayd to haue fowre ſunſtandings, that is two high ſunſtandings, when the ſunne paſſeth by their zenith (the higheſt point in the heauens) which hapneth twice euery yeare in two places, æqually diſtant from the beginnings of Cancer and Capricorne: and two low ſunſtandings, when the ſunne is in the beginning of Cancer, and Capricorne.

2. In this circle by the arch conteyned betweene the æquator and Ecliptick, we meaſure the greateſt declination of the ſunne, or obliquity of the eclipticke, which in *Ptolemees* time was 23. degr. 51. min. and one third part of a minute. But euer ſince that time it hath beene found by obſeruation to decreaſe; ſo as in this our age, it is no more then 23. degrees and one half, or little more: Notwithſtanding *Copernicus* thought that the greateſt obliquity was 23. degr. 28. minutes.

3. It ſheweth the places of the Eclipticke, in which the ſunne (comming neareſt to our Zenith) maketh the artificial day longeſt, or going furtheſt from the ſame point, maketh the ſame ſhorteſt.

4. It deuideth the zodiack into two halfes, the one aſcending, and the other deſcending.

5. Hereby alſo the ſignes are diſtinguiſhed, which doe riſe rightly, and which riſe obliquely in an oblique Sphære For the deſcending half riſeth rightly, and the aſcending halfe riſeth obliquely.

6. So the points of the ecliptick are ſhewed by this circle, wherein the greateſt difference of right & oblique aſcenſions happeneth. It diſtinguiſheth thoſe ſignes in which when the ſunne moueth, the artificial dayes are increaſed and the nightes decreaſe; from thoſe ſignes wherein the dayes are diminiſhed, and the nights increaſe.

7. In this circle are the bredths of the zones bouded; for the obliquity of the eliptick doubled, ſheweth the bredth of the torride or burnt zone; the diſtance of the poles of the ecliptick, and of the poles of the æquator, ſhew the bredth of the could or frozen zones; and the other two arches remayning, ſhewe the bredthes of the temperate zones.

The Deſcription of the two Tropicks.

CHAP. 13.

THe two ſmaller circles æquidiſtant in all places from the æquinoctial, & comming vnder theſe ſolſtitial points of the eliptick on both ſides, are called the tropicks, that is circles of returne.

And they are ſo called, becauſe that when the ſunne commeth to them, it beginneth to returne back againe towards the æquinoctial circle. Or els they may be ſo called, becauſe they are deſcribed by the turning about of the Tropical points of Cancer and Capricorne. They are alſo called ſolſtitial cirles; that is circles of the ſunſtandinges; becauſe that by reaſon of the inſenſible alteration of the declination of the eclipt ick, for ſome ſpace both before, and after the tropical points, the ſunne (in reſpect of his Meridian altitudes, or in reſpect of the motion he hath towards the north or ſouth, by reaſon of the obliquity of the Ecliptick) ſeemeth to ſtand (as it were) for certaine dayes in thoſe places.

There be two tropicks, the tropick of Cancer, & the tropick of Capricorne.

The tropick of Cancer, toucheth the Ecliptick in the beginning of Cancer, which is the moſt northerly point of the Ecliptick, or it is the tropick deſcribed in the firſt moueable ſphære, by the ſummer ſolſtitial point.

This circle is called the tropick of Cancer, becauſe it toucheth the ecliptick in the beginning of Cancer.

It is alſo called the ſummer Tropick, and the tropick of the ſummer ſunſtanding, becauſe that when the ſunne commeth to it, the ſummer beginneth. It is called the north tropick, becauſe it is in the north part of the world: and the circle of the high ſunneſtanding, becauſe the ſunne comming to it, is higheſt in the meridian, and next vnto our zenith which dwell in the north part, of the world, without the Tropicks. The Tropick of Capricorne is the Tropick which toucheth the Ecliptick in the firſt point of Capricorne. It is called the tropick of Capricorne, becauſe it toucheth the Ecliptick in the beginning of Capricorne. It is called the winter tropick and tropick of the winter ſunſtanding, becauſe the ſunne commeth to it in winter.

It is alſo called the circle of the loweſt ſun-ſtanding, becauſe that when the Sunne commeth to this Tropicke, it is furtheſt diſtant from our zenith, and hath his loweſt height in the Meridian.

Vſes of the Tropickes.

CHAP. 14.

1. THe tropicks ſhew the tropical, or ſolſtitiall points of the Ecliptick: that is, the points wherein the ſun ſeemeth to ſtand, & beginneth to returne back againe.

2. They bound out the greateſt declinations of the ſun, which in our time is about 23. degrees and an halfe.

3. Therfore they do alſo bound out the obliquity of the Ecliptick, for they are the boundes of the ſunnes way, beyond which the ſun goeth not at any tyme.

4. The ſun comming to eyther of theſe circles, is eyther neareſt, or furtheſt diſtant from our vertical point.

5. In an oblique ſphære, they meaſure out the ſhorteſt, and longeſt artificiall day and night.

6. The tropicks (aſwell in heauen as in earth,

contoyne betwixt them the Torride zone, & ſeparate it from the temperate.

The Polar Circles.

CHAP. 15.

THe two ſmalleſt circles that are next about the poles of the ſphære, are called the polar circles.

They are drawne by the poles of the Ecliptick, and are euery where æquidiſtant from the æquinoctial, and from the poles of the ſphære.

They are called polar circles, either becauſe they are neare the poles of the ſphære, or els because they are deſcribed by the motion of the poles of the ecliptick.

And therefore there be two polar circles, that is, ſo many as there are poles of the Ecliptick: the Polar circle Arctick, and the Polar Antartick.

The arctick polar circle, is that which paſſeth by the North pole of the ecliptick, or which is deſcribed by the North pole of the Ecliptick being caried about with the motion of the firſt mouable ſphære.

The antarctick polar circle, is that which goeth by the South pole of the ecliptick, being deſcribed with the firſt motion by the antarctick pole of the Ecliptick.

The diſtance of theſe polar circles from the poles of the ſphære, is æqual to the diſtãce of the tropicks from the æquinoctiall, which in our time is about 23. degr. and an halfe: for ſo much as is the obliquity of the zodiack (wherto the diſtance of the tropicks from the æquinoctial is alwayes æqual) ſo much are the poles of the eclipticK diſtant from the poles of the world.

Vſes of the Polar Circles.

Chap. 16.

1. THe polar circles ſhew the poles of the zodiack, and ſhew theyr diſtance from the poles of the æquinoctiall.

2. The temperate zones are bounded by theſe polar circles; for the arctick circle boundeth the North ſide of the North temperate zone; and the antarctick circle boundeth out the South ſide of the ſouth temperate zone.

3. The polar circles ſeparate the temperate zones, from the could zones which they compaſſe round about, and incloſe within them.

Therfore the 4. leſſer circles, that is the two polar circles, and the tropickes, deuide heauen & earth, into fiue zones.

Of the Zones.

Ch. 17.

A Zone is a ſpace of heauen, or earth, conteyned betweene two of the ſmaller Circles; or incloſed within the compaſſe of eyther polar circle.

They are called zones (that is as much to ſay as girdles) becauſe they compaſſe about heauen, or earth like a girdle.

The zones are deuided by auncient writers into two kindes; that is into temperate, & vntemperate zones.

A temperate zone is the ſpace of heauen or earth, conteyned betweene eyther of the tropicks, & the next polar circle.

There be two temperate zones; the one North, the other South.

The North temperate zone is conteyned betweene the tropicke of Cancer, & the arctick polar circle.

The ſouth temperate zone is that, which is conteyned betweene the tropick of Capricorne, & the antarctick polar circle.

They are called temperate zones, becauſe they haue a better temperature of the ayre for the moſt part, and more meet for habitation, then the vntemperate zones. The bredth of eyther temperate zone is alwayes equal to the complement of the diſtance of the tropicks, & therfore in this age is about 43 degrees, that is 2580. engliſh miles.

There be two kinde of vntemperate zones, the one exceeding in heat, the other in could, for the moſt part.

The hot vntemperate zone, (called alſo the Torride; that is, the burnt or broyled zone) is that ſpace of heauen or earth, which is conteyned betweene the tropicks.

It is called the burnt zone, becauſe that by reaſon of the ſunnes continual going ouer that zone, and caſting his beams directly downe thereupon, it is ſcorched with ouermuch heat, & is not ſo meete to be inhabited as the temperate zones.

The bredth of this zone is alwayes æqual to the obliquitie of the zodiack, or greateſt declination of the ſun, doubled; which in our time is about 47. degrees, that is 2820. engliſh miles.

The could or frozen zones, are the ſpaces of heauen or earth, conteyned within the polar circles.

There be two could zones, the one North, conteyned within the compaſſe of the Arctick circle: the other ſouth, conteyned within the compaſſe of the antarctik polar circle.

Theſe zones exceed in could, becauſe they want the ſight of the ſun for a great part of the yeare, & when the ſunne appeareth vnto them, his beams fal ſo obliquely vpon them, that they can (in al likelyhood) receyue but ſmal heat thereby for the moſt part.

The bredth of theſe zones is meaſured from the poles of the world to the polar circles, and therefore muſt alwaies be ſo much as the polar circles are diſtant from the poles: that is, in our age about 23. degrees and an half, which make 1410. Engliſh miles.

The difference of ſhadowes, that the ſunne maketh in theſe zones.

CHAP. 18.

THey that dwel in the torride zone, doe caſt theyr ſhadowes which the ſunne maketh at noone (which we may therefore call theyr noone ſhadowes) both towards the North, & towards the South: towards the North, when the ſunne is betwixt theyr zenith and the ſouth point of the Horizon; and towards the South, where the ſun is betweene theyr zenith and the North.

For ſeeing the zenith of them that dwel in that zone is betweene the tropicks, the Sun muſt needs be ſometime North-wards from their zenith, and ſo make a ſouth ſhadowe: and ſometime Southwards, and then make a north ſhadow. For which cauſe they that inhabite this zone are called *Amphiſcij*; that is, ſuch as caſt theyr noone ſhadowes on both ſides.

But they that dwell in the temperate zones, are called *Heteroſcij*; that is, ſuch as caſt theyr ſhadowes at noone, one way onely. For they that dwell in the North temperate zone, haue the ſunne allwayes at noone from theyr zenith South-wardes, and therefore muſt needes allwayes caſt theyr noone ſhadowes Northwardes. Whereas contrariwyſe they that inhabit the ſouth temperate zone, hauing the ſunne at noone alwayes north-wardes from theyr zenith, muſt needes haue their ſhadowes at noone, alwayes towards the ſouth.

And they that are in the could zones, are called *Periſcij*; that is, ſuch as caſt theyr ſhadowes round about them. For ſeeing the ſunne contínueth euery yeare for certayne dayes togither, alwayes aboue theyr Horizon, and therefore moueth round about them without ſetting: it muſt needes be that theyr ſhadowes alſo are caried round about them, falling towards al parts of the world in the ſpace of 24. howres.

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THE

The Second Part of the Vses of the Uppermost
Sphaere And of the Circles

The ſecond Part.

Of the vſes of the vppermoſt SPHÆRE, and of the circles thereof ioyntly.

To rectifie the ſphære; that is, to ſett the ſphære to the latitude of that place for which you would vſe it.

PROP. I.

FIRST finde by obſeruation, or otherwiſe the height of the pole, or latitude of that place for which you would rectify the ſphære. Then (by turning about the Meridian of the ſphære, lift vp or put downe the north pole of the ſphære (about which the howre circle is faſtned) til the arch of the Meridian from the north part of the Horizon vpwards vnto the pole, be iuſt ſo many degrees as the eleuation of the

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of the pole or latitude of the place was founde to be: for ſo haue you the ſphære duely rectified.

As for example, the latitude of the Citty of London is 51. degrees and 32. minutes, therefore if you lift vp the North pole of the ſphære, aboue the North part of the Horizon, ſo many degrees & minutes you ſhal haue your ſphære rectified for that place.

To know the place of the Sunne (that is, the point of the Ecliptick in which the center of the Sunne is) any time by this Sphære.

PROP. 2.

LOoke the day of the moneth (for which you deſire to know the place of the ſunne) in the Horizon, and ſee what ſigne and degree of the zodiack vpon the Horizon anſwereth therto; for there haue you the place of the ſunne.

Take for example the 25. of December: looke this day therefore in the Horizon, and you ſhal find aunſwerable thereto 13. degrees, and about 40. min. of Capricorne, which is the place of the ſunne at that time.

To know the declination of the Sunne, or of any point of the Eclipticke.

Prop. 3.

BRing the point whoſe declination you deſire to know, vnto the Meridian of the Sphære; & look what number of degrees & minutes of the meridian is conteyned betweene that point and the æquinoctial, for ſo much is the declination.

As if you would know the declination of the 10 degree of Taurus, bring that degree to the Meridian, & you ſhall finde the arch of the meridian betweene that degree & the æquinoctial, to be 14. degrees and about 51. min.

To know the right aſcenſion of the ſunne, or of any point of the zodiack.

Prop. 4.

BRing that point (as before) to the Meridian, & ſee then how many degrees and minutes of the æquinoctial are conteyned betweene the beginning of Aries and the Meridian: for that is the right aſcenſion of that point. So you ſhal finde the right aſcenſion of the 10. degr. of Taurus to be 37. degr. 35 min: for if you bring that degree of Taurus to the Meridian, you ſhal finde ſo many degrees and min. betweene the beginning of Aries, and the meridian.

To know the oblique aſcenſion of the Sunne or of any ſtarre or point in the zodiack.

Prop. 5.

SEtt the ſphære to the eleuation of the place for which you deſire to know the oblique aſcenſion; then bring the ſunne, ſtarre, or point whoſe oblique aſcenſion you would know, vnto the eaſt ſemicircle of the Horizon, and looke how many degrees and minutes of the æquinoctial circle, are conteyned betweene the Eaſt point of the Horizon, and the beginning of Aries; for ſo much is the oblique aſcenſion deſired: As for exãple, if you ſet the ſphære to the latitude of London 51. deg. 32. min. and then bring the 10. degree of Taurus to the Eaſt part of the Horizon, you ſhal finde about 29. degrees & an half of the æquinoctial, at the ſame Eaſt part of the Horizon; which is the oblique aſcenſion of that degree of Taurus, for the latitude of the cittie of London.

To finde the differrence of Aſcenſion.

Prop. 6.

COmpare the right and oblique aſcenſions of the ſunne, (or of any point of the zodiack) together, and ſubtract the leſſe from the greater, for the remainder ſhal be the difference of aſcenſion. As for example, the right aſcenſion of the 10. degr. of *Taurus*, being found by the 4. prop. to be 37. degree 35. min. and the oblique aſcenſion of the ſame degr.

degree at London, by the 5. Prop. 19. degree 30. min. by ſubtraction of the leſſe out of the greater, the difference ſhalbe found to be 18. degr. and 5. min. which is the difference of aſcenſion ſought for.

To finde at what time the Sunne riſeth or ſetteth.

PROP. 7.

REduce the difference of Aſcenſion into howres and minutes (taking for euery 15. degrees 1. howre, and for euery one degree that remayneth 4. minutes, and for euery minute of a degree 4. ſeconds) for theſe howres, minuts & ſeconds, being added to 6. howres, if the ſunne be in any of the South ſignes; or ſubtracted, if he be in the North ſignes, ſheweth the tyme of the ſun-riſing. And contrariwyſe, the ſame howres and minutes ſubtracted from ſix howres when the ſunne is in the South-ſignes, or added when he is in the North ſignes, ſheweth the time of the ſun-ſetting.

As for example the Sunne being in the 10. deg. of *Taurus* (which happeneth abont the 20. or 21. day of April) I would know at what howre & minute the Sunne riſeth, and ſetteth at London: Hauing therefore found by the former propoſition the difference of aſcenſion to be 18. degr. and 5. minutes I take for 15. degrees therof one howre, & for the three degr. remayning, 12. minutes of an howre, & for the 5. minutes, 20 ſeconds of an howre. Which howre, minutes and ſeconds being ſubtracted out of 6. howres, becauſe the ſunne is in a North ſigne, there remayneth the time of the ſunnes riſing at 4 a clock 47. minutes, 40 ſeconds. And adding the ſame howre, min. and ſeconds to 6 howres, you haue the time of the ſun-ſetting that day at 7. a clock 12 min. & 20 ſeconds.

To finde the length of the artificiall day or night.

Prop. 8.

The artificial day, is the time conteyned between the ſunne-riſing and the ſunne-ſetting: and the artificiall night is the time betweene ſun-ſetting & ſun-riſing. The length of both theſe is found after this manner: hauing found the difference of aſcenſion, and reduced it into howres and minutes (as in the former propoſition) double thoſe howres & minutes, and add them to 12 howres if the ſunne be in the North ſignes, or ſubtract them from 12 howres if the ſunne be in the ſouth ſignes, for ſo ſhal you haue the length of the day: But (contrariwyſe) ſubtract the ſame howres & minutes (being doubled) from 12. howres, the ſun being in the north ſignes; and add them to 12. howres when he is in the ſouth-ſignes; ſo haue you the length of the night.

Or els, double the time of the ſun-ſetting, ſo haue you the length of the day. And double the time of the ſunne-riſing, ſo haue you the length of the night.

As the time of the ſun-riſing being found by the former propoſition to be 4 howres 48 minutes after midnight at London, the ſunne being in the 10 degr. of *Taurus*, by doubling the time of the ſun-riſing, the length of the night ſhal be found to be 9 howres and 36 minutes. And doubling the time of the ſun-ſetting, that is 7 howres, and 12 minutes, you haue the length of the day, 14 howres, & 24. minutes.

To know the time of the ſunne-riſing and ſun-ſetting otherwiſe by the Sphære.

PROP. 9.

THE place of the ſunne being found by the 2. propoſition, bring the ſame to the Meridian, and withall ſet the point of the index of the howre circle, to the 12 howre in the ſame circle: Then bring the place of the ſunne to the Horizon eaſtwardes; and the point of the howre index ſhall ſhew you in the howre circle, the time of the ſun-riſing. But if you bring the place of the Sun to the horizon weſt-wards, the point of the index wil ſhew in the howre circle the time of the ſunne-ſetting.

As for example, the ſunne being in the 10 degr. of *Taurus*; bring the ſame degree to the Meridian, and bring the point of the howre index alſo to the meridian: then (the Sphære being ſet to the latitude of London) bring the ſame 10 degr. of *Taurus* to the eaſt part of the horizon, for then the howre index will ſhew you in the howre circle, that the ſunne riſeth at 4 of the clock and 48 minutes.

And bringing the ſame degree to the VVeſt ſemicircle of the Horizon , the ſame Index will ſhew the time of the Sun-ſetting to be 7 howres and 12. min. after noone.

To finde the length of the artificiall day or night otherwyſe by the Sphære.

PROP. 10.

BRing the place of the ſun (being found as before to the Eaſt ſemicircle of the Horizon : ſett the howre index to 12 a clock in the howre circle: turne about the ſphære from the Eaſt, Weſtwards, till the place of the ſun come to the Horizon, & mark how many howres the index hath runne ouer vpon the howre circle in the meane time, for ſo much is the length of the day.

And to finde the length of the night : Bring the place of the ſunne to the VVeſt ſemi-circle of the Horizon, and ſet the index to 12 a clock as before. Then turning forwards the ſphære from Eaſt Weſtwarde til the place of the ſunne come to the Eaſt ſemicircle of the Horizon; ſee how many howres the index paſſeth ouer in the howre circle, for ſo many howres long is the night.

As for example; ſuppoſing the ſunne to be as before in the 10 degr. of *Taurus*, bring the ſame degree to the Eaſt part of the Horizon, and the point of the index to the meridian : then turning about the ſphære, till the ſame degree come to the Weſt part of the horizon ; you ſhall finde that in the meane time, the point of the Index ſhall paſſe ouer 14 howres and 24 min. which is the length of the day. Likewiſe, if you bring the ſame 10 degree of *Taurus* to the weſt part of the horizon, and the index to the meridian, and turne about the ſphære, til that degree come to the eaſt ſemicirle of the horizon, the number of howres that the index runneth ouer in the meane time vpon the howre circle, ſhall be founde to be nine degrees, and 36. minutes.

To know the meridian altitude, or the height of the Sunne at noone for any time and place (whoſe latitude is knowne)

PROP. 11.

SET the ſphære to the latitude of the place where you deſire to know the ſunnes height at noone: bring the place of the ſunne (being found as before by the 2 Prop.) to the meridian, then ſee how many degrees of the meridian, are conteyned betweene the horizon, and the place of the ſun, for ſo much is the height of the Sunne at noone.

In like ſorte it may be knowne how much the ſunne is vnder the horizon at midnight, after this manner: Bring the place of the ſunne in the zodiack to the meridian vnder the horizon, and ſee how many degrees of the meridian, are conteyned betweene the vpper ſide of the horizon, and the place of the ſunne downwards: and ſo ſhal you haue that you ſought for.

Or els if you cannot well come to the Meridian vnder the horizon: Bring that point of the ecliptick which is oppoſite to the place of the ſun, vnto the Meridian aboue the horizon; for the arch of the meridian, or the number of degrees and minutes of the meridian, betweene that point and the horizon ſheweth how much the ſunne is vnder the horizon at midnight.

After this manner, the ſunne being in the 10. of *Taurus*, you ſhall finde that his Meridian altitude at London is fifty three degrees, and about one halfe.

As alſo that he is vnder the horizon at midnight about 23 degrees and a halfe at London.

To know how high the Sunne is aboue the Horizon at any time of the day.

PROP. 12.

BRing the place of the ſun (found by the 2 Prop.) to the Meridian: ſet the howre index to 12. a clock vpon the howre circle: turne the ſphære about till the index come to the howre at which you deſire to know the height of the ſunne aboue the horizon; take the diſtance of the place of the ſun from the horizon with a large payre of compaſſes: then ſet both feet of the compaſſes in the ecliptick, and looke how many degrees are conteyned betweene them, for ſo much is the height of the ſun.

Thus may you find by the Sphære, that when the ſunne is in the tenth degree, of *Taurus*, his height at 10. of the clock in the fore-noone (the

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Sphære being duely rectified by the firſt propoſition) ſhall be about 45. degrees and an halfe at London.

To finde the howre of the day by the height of the ſunne; the place of the ſunne, & the height of the pole being giuen.

SEt the pole arctick of the Sphære to his eleuation for that place where you deſire to know the howre of the day: bring the place of the ſunne in the zodiack to the meridian, and the howre index to 12. a clock of the howre circle: take ſo many degrees of the ecliptick betweene the feet of your compaſſes, as the height of the ſunne amounteth vnto.

Then ſet one foot of your compaſſes in the place of the Sunne, and turne the ſphære about, Eaſtwards, if it be in the fore-noone, or Weſt-wards, if in the after noone, till you can but only touch the horizon with the other foote of your compaſſes; for then the index pointeth out the howre of the day in the howre circle.

As ſuppoſe you obſerue the height of the ſun being in the 10 degr. of *Taurus*, and finde him to be 30 degr. high in the fore-noone: you ſhal finde (following the directions præſcribed in this propoſition) that it ſhall then be about 8. of the clock in the morning.

To finde the amplitude or bredth of the ſunnes riſing, or ſetting: that is how farre he riſeth or ſetteth from the point of true Eaſt, or Weſt at any time.

PROP. 14.

THe pole of the Sphære being ſet to his eleuation, and the place of the ſunne to the Eaſt ſemicircle of the horizon: ſee how many degrees of the horizon, are conteyned betweene the place of the ſun, & the true Eaſt point, for ſo you ſhall haue the bredth of the ſunnes riſing.

Thus the ſunne being in the 10. degr. of *Taurus*, you ſhal finde by the ſphære, that (for the latitude of London) he riſeth about 23 degr. and an halfe North-wards, from the true Eaſt point, and that he ſetteth as many degrees towards the North, from the true Weſt point.

To finde the place of the ſunne: his declination and the quarter of the yeare being firſt knowne.

PROP. 15.

THe quarter of the yeare being knowne, bring the quarter of the Ecliptick that is aunſwerable thereto, vnder the Meridian; and turne the ſphære to or fro, till there be ſo many degrees & minutes o the Meridian, conteyned betweene the ecliptick and the æquator, as the declination commeth to:

then looke what degree of the Ecliptick is vnder the Meridian, for that is the place of the Sunne.

As ſuppoſe the declination of the ſun in ſome day of the ſpring time of the yeare be found to be 14 degr. 51. min. (turning therefore the ſphære to and fro, till ſome part of the ſpring quarter of the Ecliptick, come right vnder that degree & minute of declination in the Meridian) you may finde that the ſunne is then in the tenth degree of *Taurus*.

To finde what day of the moneth it is, by knowledge of the Sunnes declination.

PROP. 16.

THe place of the ſunne being found by his declination (as is already ſhewed) ſeeke the place of the ſunne in the horizon of the ſphære, & looke what day is aunſwereable thereto, for that is the day of the moneth which was ſought for.

As the place of the ſunne being found by his declination (as is ſhewed in the former propoſition) to be in the 10. degree of *Taurus*, the day of the moneth ſhall thus be found to be the 21. of April.

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To finde the amplitude or bredth of the ſunnes riſing, or ſetting: that is how farre he riſeth or ſetteth from the point of true Eaſt, or Weſt at any time.

PROP. 14.

THe pole of the Sphære being ſet to his eleuation, and the place of the ſunne to the Eaſt ſemicircle of the horizon: ſee how many degrees of the horizon, are conteyned betweene the place of the ſun, & the true Eaſt point, for ſo you ſhall haue the bredth of the ſunnes riſing.

Thus the ſunne being in the 10. degr. of *Taurus*, you ſhal finde by the ſphære, that (for the latitude of London) he riſeth about 23 degr. and an halfe North-wards, from the true Eaſt point, and that he ſetteth as many degrees towards the North, from the true Weſt point.

To finde the place of the ſunne: his declination and the quarter of the yeare being firſt knowne.

PROP. 15.

THe quarter of the yeare being knowne, bring the quarter of the Ecliptick that is aunſwerable thereto, vnder the Meridian; and turne the ſphære to or fro, till there be ſo many degrees & minutes o the Meridian, conteyned betweene the ecliptick and the æquator, as the declination commeth to:

then looke what degree of the Ecliptick is vnder the Meridian, for that is the place of the Sunne.

As ſuppoſe the declination of the ſun in ſome day of the ſpring time of the yeare be found to be 14 degr. 51. min. (turning therefore the ſphære to and fro, till ſome part of the ſpring quarter of the Ecliptick, come right vnder that degree & minute of declination in the Meridian) you may finde that the ſunne is then in the tenth degree of *Taurus*.

To finde what day of the moneth it is, by knowledge of the Sunnes declination.

PROP. 16.

THe place of the ſunne being found by his declination (as is already ſhewed) ſeeke the place of the ſunne in the horizon of the ſphære, & looke what day is aunſwereable thereto, for that is the day of the moneth which was ſought for.

As the place of the ſunne being found by his declination (as is ſhewed in the former propoſition) to be in the 10. degree of *Taurus*, the day of the moneth ſhall thus be found to be the 21. of April.

The day of the moneth being knowne, to finde at what time the day breaketh.

Prop. 17.

Finde the place of the ſunne (by the 2. prop.) & bring it to the Meridian, then bring the howre index to 12. a clock vpon the howre circle.

Finde out alſo the point of the Eclipticke that is right ouer againſt the place of the ſunne: then take betweene the feet of your compaſſes 17 degr. of the ecliptick, and ſetting one foote of the compaſſes in the point oppoſite to the place of the ſunn, turne the Sphære Weſt-wards, til you can but only touch the horizon with the other foote, for then the index ſheweth in the howre circle at what time the day breaketh.

So the 21. of April, the ſun being in the 10 degr. of *Taurus*, you ſhal finde that the day breaketh about halfe an howre paſt two of the clocke in the morning.

To finde how long the twylight continueth.

Prop. 18.

Finde out by the former Prop. at what time the day breaketh, and learne alſo at what time the ſunne riſeth by the 7. or 9. prop.

Then ſubtract the leſſer from the greater, and there ſhall remayne the length of the twylyght.

Or els thus: hauing brought the point that is oppoſite to the place of the ſunne to be 17 degrees aboue the horizon VVeſt-wards, in ſuch ſorte as is ſhewed in the former propoſition; and keeping the ſphære in that poſition, bring about the point of the howre index vnto 12 a clock vpon the howre circle; then turne the ſphære VVeſt-wards vntil the degree or point of the ecliptick that is oppoſite to the place of the ſunne come to the Horizon: and ſee how many howres the point of the index hath run ouer in the meane time vpon the hower-circle: for ſo many howres continueth the twylight.

By eyther of theſe wayes, the ſunne being in the 10. deg. of *Taurus*, you ſhal finde that the twylight (that is the time from the breake of the day till Sun riſe) is about 2. howres and 20 minutes.

To finde how much the declination of the ſunne muſt alter at any time of the yeare, to make the day an howre longer or ſhorter.

Prop. 19.

BRing the place of the ſunne (found by the ſecōd Prop.) to the Eaſt ſemicircle of the horizon, & marke what degree or point of the horizon it falleth vpon; bring one of the Colures to the ſame degree or point, and there make a prick in that colure; and (houlding the ſphære immoueable,) marke withall what degree of the æquinoctiall, or of eyther of the tropicks is then at the horizon: Then turne the ſphære 7 degr. and an halfe forwards, towards the VVeſt, if the dayes ſhorten: but contrariwiſe if the dayes lengthen; & houlding the ſphære there immoueable, make another prick in the colure at the horizon: for the diſtance of theſe two pricks in the colure taken with the compaſſes and brought to the ecliptick, or æquinoctial, ſheweth how much the ſunnes declination muſt alter to make the day an howre longer, if the dayes increaſe; or ſhorter, if they decreaſe.

After this manner you ſhall finde that the ſun being in the 10. degree of *Taurus*, his declination muſt increaſe about 5 degrees, (or little more) to make the day an howre longer; but when the ſunne is in the 20 degr. of *Piſces*, his declination, or rather his meridian altitude, muſt increaſe about *6* degr. to make the day an howre longer: and when he is in the beginning of Capricorne, his declination decreaſeth ſcarce 5 degrees to make the day an howre longer.

To finde how many dayes it is ere the day lengthen or ſhorten an howre.

Prop. 20.

BRing the foreſayd pricks (made in the colure by the former propoſition) vnto the meridian, and there make two markes iuſtly aunſwereable vnto thoſe pricks in the colure: turne about the ſphære till the eliptick line come iuſt vnder one of thoſe markes, & there make a prick in the ecliptick: then againe turne the ſphære til the ecliptick come iuſt vnder the other marke made in the meridian, and there make another prick in the ecliptick: (But here it is to be noted, that wheras the ecliptick may be brought vnder that marke whether way ſoeuer you turne the Sphære; it muſt (I ſay be noted that the ſphære muſt be turned that way which may ſooneſt bring the ecliptick vnder that marke. (Laſtly, finde out amongſt the ſignes and degrees deſcribed vpon the Horizon, the like arch to this, that is conteyned betweene theſe pricks in the ecliptick: For the number of dayes anſwerable to this arch in the horizon, is the time wherein the day groweth an howre longer or ſhorter.

Thus ſhal you finde, that when the ſunne is in the beginning of Aries, it will be about 18. dayes after, ere the day be one howre longer. But when the ſunne is in the beginning of Capricorne, you ſhall finde that it will be almoſt twice ſo much, that is neare 34. dayes before the day will be an howre longer.

Hereby therfore the error of them manifeſtly appeareth, which think that in euery 15. dayes the day is lengthned or ſhortned an howre, wheras indeede the lengthning or ſhortning of the dayes, keepeth no ſuch rule. For when the ſunne is about the æquinoctial points, the dayes lengthen or ſhorten very faſt: but when he is neere the tropical points, they grow longer or ſhorter very ſlowely.

To make an horizontal Diall by the Sphere.

Prop. 21.

SEt the ſphære to the eleuation of the place for which you would make the Dial turne about the ſphære, til the ſolſtitial colure be 15 degrees (meaſured in the æquinoctial) from the meridian; and where the colure croſſeth the horizon, there make a prick; then turne the colure yet 15 degr. further, that is 30 degr. from the meridian; and where the colure croſſeth the horizon, there make an other prick: againe turne the colure forwards yet 15 deg. more, (that is 45 degrees from the Meridian) and at the common meeting of the colure and horizon, make the third prick in the horizon: and ſo proceed with the reſt, till you haue made ſo many pricks on that ſide of the horizon as there are howres in half the longeſt day. Then looke how many degrees the firſt, ſecond, third, fourth pricks, &c. are from the Meridian, for ſo many degrees muſt the howre lines of 11 a clock and one a clock; of 10. and 2, of 9. and 3. of 8. and 4. &c. be from the 12. a clock line in the horizontal dyal.

After this manner in an horizontal dial made for the latitude of London, (which is 51 degr. and 32 minutes) you ſhal finde the diſtaunces of all the reſt of the howre lines from the 12. a clock line as followeth: Betwixt twelue and 11. and 12. and 1. are conteyned 12 degrees almoſt: Betweene 12. and 10. and 12. and 2. there are conteyned 24 degr. and an halfe: Betweene 12. and 9. and 12. and 3. 38 deg. Betweene 12 and 8, and 12. & 4. 53 degr. Betweene 12. and 7. and 12. and 5. 70 degr. and an half.

☞ Betweene 12 and 6. both before and after noone, 90 degr. The other howre-ſpaces before 6. in the morning, and after 6 in the euening, are æqual to the hower-ſpaces after *6* in the morning, & before *6* in the after noone.

How to make a direct mural diall by the Sphære.

Prop. 22.

SEt the pole arctick of the Sphære ſo much vnder the Horizon as is the complement of the poles eleuation: the Horizon therefore being thus ſet as it were to the zenith of the ſphære, and ſo repreſenting the verticall circle of Eaſt and Weſt (that is the plaine ſuperficies of a direct mural dial) you ſhall finde the diſtaunces of all howre lines, (both before and after noone) from the 12 a clock line, in ſuch ſorte as you did before for the Horizontal dial.

So you ſhal finde the diſtaunces of the howre lines in an erect direct mural dial made for the latitude of London to be as followeth: Betweene the twelue a clock line and the lines of 11 and 1, 9 degr. and about one third part of a degree: Betweene 12. and 10. and 12. and 2, 19 degrees and one quarter; Betweene 12 and 9, and 12 and 3, 32 degr. or little more: Betweene 12 and 8, and 12 and 4, 48 degrees: betweene 12 and 7, and 12 and 5, 67 degr. or little more: betweene 12 and 6. both before and after noone 90. degrees.

How to make any direct inclining, or direct reclining diall by the Sphere.

PROP. 23.

REckon from the æquinoctial vpwards in the Meridian, ſo many degrees as the height of the pole commeth to at that place where you would make your diall; for there is the verticall point or zenith of that place: from this zenith reckon ſouthwards in the meridian, the inclination of ſouth dials and the reclination of North dialls; but contrarywiſe, reckon from the zenith North-wards the inclination of North dials and the reclination of South Dials. Then bring that degree of the meridian where this reckoning endeth to the Horiſon, for ſo the Horizon repreſenteth vnto you the plaine or the flat ſuperficies of the dial which you would make. Therefore you ſhal finde how many degrees euery one of the howre lines ſhould be diſtant from the 12. a clock line, in ſuch ſort as you did before in making the Horizontal dial.

Thus in a South direct dial inclining 30 deg. or in a North direct reclining 30 degr. made for the latitude or eleuation of the pole at London, you may finde the diſtances of the eleuen a clock line & of the one a clock line, from the 12 a clock line, to be about 14. degrees.

But the howre lines of 10. in the forenoone and of 2 in the afternoone, are diſtant from the 12 a clock line 28 degr. and on half; From 12 to *9*. and to 3, you ſhal finde 43 degr. From 12 to 8 in the fore noone, and 4 in the after noone, you ſhall haue 58 degr. & an halfe: alſo from 12 to 7, and to 5, ſhal be about 74 degr. And from 12 to *6* in the morning, & *6*. after noone *9*0 degrees.

Likewiſe in a South direct reclining, or North direct inclining 20 degr. for the eleuation of London; the ſpaces betweene 12 & 11 & 12 & 1, ſhal be about 5 deg. or little leſſe: Betweene 12 & 10, & 12. & 2, about 10 deg. & 2 third parts. From 12 to *9* in the forenoone, & 9 in the afternoone, 18 almoſt: Frõ 12 to 8, & 4, 29 degr. or little more. From the 12. a clock line, to the line of 7 a clock in the forenoone, & 5 in the afternoone, 50 degr. or there abouts. Frõ 12 to *6* both before & after noone, 90 deg. as in the former kindes of dials. In al which it is to be noted, that there is alwayes the ſame diſtance between the howre lines of 5 & *6*, & 4 & *6* that there is between 7 and *6* and 8. & 6 in the forenoone, and betweene 5 & *6*, & 4 & 6 & 7 & *6*, & 8, & *6*. in the after noone. So as the diſtances of al the howre lines from the 12 a clock line being found from *6* in the morning, till 6 at night, the diſtances of the other howre lines before *6* in the morning, and after *6* at night ſhall eaſely be had.

To know at what time the moone, or any other of the planetes or fixed ſtarres, that are within the bredth of the zodiack; riſe, or ſet, or come to the meridian; as alſo with what degree of the ecliptick they riſe or ſet or mid heauen, togither with their declinations, and their right and oblique aſcenſions, and deſcenſions; and theyr bredths or amplitudes of riſing, or ſetting.

Prop. 24.

Finde the place of the moone, or any other of the planetes, both in longitude and latitude, by the Ephemerides: and finde the place (that is, the longitude and latitude) of any of the fixed ſtarres in the zodiack by ſome table of the fixed ſtarres, or otherwiſe; and marke the ſame place of the moone, planete or ſtarre, in the zodiack of the ſphære: and hauing ſet the ſphære to the latitude of the place, bring the place of the ſunne (found by the 2. propoſition) to the meridian, and the howre index to 12 a clock vpon the howre circle; then turne the Sphære till the place of the moone, planet or ſtarre marked in the zodiack, come to the eaſt ſemicircle of the horizon; for then the index ſheweth the time when the moone, or that planet or fixed ſtarre, riſeth.

Alſo the number of degrees in the Horizon, conteyned betweene the point of the moones, planetes, or ſtarres, riſing, and the point of true Eaſt,

ſhew

ſheweth the bredth, widenes or amplitude of riſing; And you may at the ſame inſtant ſee, what degr. of the ecliptick riſeth with any of them, and what the oblique aſcenſion of any of them is: For if you tell how many degrees of the æquinoctial are conteyned betweene the beginning of Aries and the Horizon, proceeding Eaſt-wards, or according to the order of the ſignes: you ſhall haue the oblique aſcenſion of the moone, planete, or ſtarre that you ſought for.

But bring the ſame place of the moone, planete or ſtarre to the meridian, and the index ſheweth in the howre circle at what time they come to the meridian: where you may alſo ſee, firſt what degree of the zodiack middeth heauen (that is, commeth to the meridian) with any of them; ſecondly you may ſee how much the declination of any of them is; for count how many degrees of the meridian are conteyned betweene the æquinoctial and the place of the moone, planete, or fixed ſtarre, and ſo much is the declination. Thirdly you may there ſee what the right aſcenſion of any of them is: for the place of any of them being brought to the meridian and there ſtayed, reckon Eaſt-wards how many degrees of the æquinoctial are conteyned betweene the beginning of Aries and the Meridian, ſo haue you the right aſcenſiō: Laſtly bring the place of the moone, planete, or ſtarre, to the VVeſt ſemicircle of the Horizon; for then the index ſheweth the time of theyr ſettings; and the number of the degrees of the Horizon betweene the point where any of them ſetteth; and the æquinoctial, or true VVeſt point (where the æquinoctial, and Horizon croſſe each other) is the amplitude or bredth of the ſetting of any of them, ſhewing how much they ſet from the true VVeſt point.

You may there alſo ſee what degree, eyther of the ecliptick, or of the æquinoctial, ſetteth with any of them: and conſequently you may know the oblique deſcenſion of any of them, by reckoning how many degr. of the æquinoctial there are from the beginning of Aries Eaſtwards, till you come about to the VVeſt part of the Horizon.

Take for example the great ſtarre called the Bulles eye, whoſe place in longitude is about the 4. deg. of Taurus, and his latitude about 5 degr. and an half Southwards.

Following therefore the directions præſcribed in this propoſition, you ſhal find that vpon the firſt day of April this preſent yeare 1600. the ſame ſtarre ryſeth here at London about half an howre paſt 7. of the clock in the morning, and ſetteth about a quarter of an howre paſt 10 at night, and commeth to the meridian about 3 a clock afternoone: Alſo you ſhal find that it riſeth with the 15 degree of Gemini, and ſetteth with the laſt deg. of Taurus, and commeth to the meridian, or middeth heauen, with the 5. deg. of Gemini: Thirdly you ſhal find his declinatiō to be about 15 deg. & 2 third parts, his right aſcenſion 63 degr. and a quarter, his oblique aſcenſion 43 degr. and his oblique deſcenſion about 84. deg. and an half: and laſtly his amplitude or bredth of riſing, or ſetting about 25 degr. & an halfe from the true Eaſt & VVeſt points towards the North.

To know how long the moone or any of the planets or fixed ſtarres do ſhine or continue aboue the Horizon.

Prop. 25.

THe Sphære being ſet to the latitude of the place, and the place of the moone, planete, or fixed ſtarre, being found, & marked in the zodiack, both in longitude, and latitude, (as in the former prop.) bring the place of the moone, planete, or ſtar, to the Eaſt ſemicircle of the Horizon, and the index of howres to 12. a clock: Then turne about the Sphære Weſt-wards, till the ſame place of the Moone, or of the ſame planete, or ſtarre, come to the Weſt ſemicircle of the Horizon, and marke withall how many howres the index runneth ouer in the meane time vpon the howre circle, for ſo many howres continueth the moone, planete, or ſtarre aboue the Horizon.

Thus ſhall you finde that the foreſayd ſtarre (called The Bulles eye) continueth, or ſhineth aboue the horizon at London, about 14. howres & 3. quarters.

To finde which of the planetes or fixed ſtarres are aboue or vnder the Horizon at any time of the day or night.

Prop. 26.

THe places of the planetes or fixed ſtarres being marked in the zodiack of the Sphære, as in the former propoſitions, and the place of the ſunne brought to the Meridian, and then the index to 12 a clock; turne the ſphære til the index come to that howre vpon the howre circle at which you deſire to know what planetes are aboue or vnder the Horizon, and then hould ſtil the ſphære, and marke what planetes or ſtarres are aboue, or vnder the horizon in the ſphære, for the ſame planetes or ſtarres are aboue or vnder the horizon in the heauens.

As for example: the 1. of April 1600. at 9. of the clock at night, you may by this propoſition finde, that the moſt part of the fixed ſtarres, that are in the conſtellations of *Taurus*, *Gemini*, *Cancer*, *Leo*, *Virgo*, and *Libra*, togither with the three ſuperiour planetes, *Saturne*, *Iupiter* & *Mars*, are at that howre to be ſeene aboue the Horizon; & that the reſt of the planetes and fixed ſtarres, that are within the compaſſe of the zodiack, are vnder the horizon, and cannot then be ſeene.

To finde in what time any ſigne or part of the ecliptick riſeth or ſetteth.

Prop. 27.

BRing the beginning of the ſigne, or part of the ecliptick, to the Eaſt ſemicircle of the horizon, if you would knowe in how long time it riſeth, or to the weſt part of the horizon, if you would know in what time it ſetteth; then ſet the index to 12 a clock and turne forwardes the Sphære, til the whole ſigne or part of the zodiack be riſen, or ſet: For then the index ſheweth vpon the howrecircle in how long time, that ſigne or part of the zodiack riſeth or ſetteth.

Thus you may finde (for example) that the whole ſigne of Aries here at London riſeth in one howre or ſomewhat leſſe, and ſetteth in two howres & three quarters, or ſomthing more: And that the whole quarter of the zodiack, from the beginning of Aries to the beginning of Cancer, riſeth in leſſe then 4 howres, but ſetteth in more then 8 howres.

To finde the howre of the night by any of the planettes, or fixed ſtarres in the zodiack, that appeare aboue the Horizon.

Prop. 28.

THe place (that is to ſay the longitude & latitude) of any planete, or fixed ſtarre in the zodiacke, that is aboue the horizon, being firſt found, and marked in the zodiack of the ſphære; bring the place of the ſunne (found by the 2 propoſition) to the meridian, & the index to 12 a clock vpon the howre circle: Then hauing found the height of the ſtarre, or planete by obſeruation, and the ſphære alſo being ſet to the latitude of the place of obſeruatiō, take betweene the feet of your compaſſes, ſo many degrees of the ecliptick, or æquinoctiall, as the height of the planete, or ſtarre obſerued, commeth to; and ſetting one foote of your compaſſes in the place of the planete, or fixed ſtarre that you obſerued in the zodiack, turne the ſphære forwards, or backwards, till you can but onely touch the horizon with the other foote: for then the index in the howre circle, ſhall ſhew you the howre of the night.

Suppoſe (for example) I ſhould obſerue the height of the foreſayd Bulles eye, and ſhould finde the ſame to be 29. degrees the firſt day of March at euening: finding therfore the place of that ſtarre in the zodiack of the Sphære, and bringing it (with help of the compaſſes) to the height obſerued (hauing firſt ſet the place of the ſunne and howre-index both togither to the meridian) the index of the howres will ſhewe, that when that ſtarre hath that height of 29 degrees, it is about 9 of the clock at night.

To know at any time of the yeare, what ſtarres in the Zodiack, ariſe, or ſett, Coſmically, Achronycally, or Heliacally.

Prop. 14.

SVch ſtarres as riſe togither with the ſunne, are ſayd to riſe coſmically: and ſuch ſtarres as ſett when the ſunne riſeth, are ſaid to ſet coſmically; But thoſe ſtarres which ſet togither with the ſunne, ſet achronycally; and thoſe ſtarres that riſe when the ſunne ſetteth, are ſayd to riſe achronycally. Laſtly thoſe ſtarres that riſe a little before the ſunne, riſe heliacally; and thoſe that ſet a little after the ſunne, ſet heliacally.

All which may thus be found: Bring the place of the ſunne to the Eaſt ſemicircle of the Horizon: for the ſtarres that are then a litle aboue the horizō riſe heliacally: but thoſe that are in the horizon in the Eaſt, riſe coſmically; and they that are in the VVeſt ſemicircle of the horizon ſet coſmically: But bring the place of the ſunne to the VVeſt ſemicircle of the horizon, for thoſe ſtarres that are at the VVeſt part of the horizon at the ſame time, ſet achronycally; but thoſe that are then in the Eaſt ſemicircle of the horizon, riſe achronycally: & they which are a little aboue the VVeſt ſemicircle of the horizon ſet heliacally.

Thus you may know that vpon the ſix or ſeuen & twentith day of May (in our latitude of London) the Bulles eye riſeth coſmically, and the ſtarres in Serpentarius his right foote, ſet coſmically, you may ſee alſo that the ſame day the ſtarre in the Buls South horne ſetteth achronycally : and the northermoſt ſtarre in Serpentarius his right foote, riſeth achronycally : and laſtly you may finde that about the ſame time the Pleiades & the ſtarre in the Bulles north horne, riſe heliacally, & that the ſame ſtarre alſo, and the former Twinnes feete ſet heliacally.

To finde the fowre principall or Cardinall points of Heauen (as the aſtrologians call them) at any time.

Prop. 30.

THeſe fowre cardinal points are nothing els but 4 points of the ecliptick, whereof one is at the Eaſt part of the horizon, aſcending, and is therefore called the aſcendent : another is at the vpper part of the meridian aboue the horizon, and is called the midſt of heauen, and the hart of heauen: the third is at the VVeſt part of the horizon deſcending, and may be therfore called the deſcendent: the forth point is that which is at the nether part of the meridian vnder the horizon. VVhich fowre points are the beginnings of the firſt, tenth, ſeauenth, and fowrth howſes. Therefore to finde theſe points at any time by the ſphære, bring the place of the ſun (being found for that time by the 2 propoſition) to the meridian, and the index to 12 a clocke: then turne the ſphære till the index come to that howre at which you deſire to know thoſe fowre points, & there hould the ſphære that it moue not: and looke withall, what points of the ecliptick are at the Eaſt and Weſt ſemicircle of the horizon; and at the vpper and nether parts of the Meridian: for thoſe be the fowre principall or Cardinall pointes you ſought for.

Take for example the time of the Sunnes entrance into Aries this preſent yeare 1600. which was vpon the tenth day of March about eight of the clock in the morning, or little after with vs heere at London. Hauing therefore brought the beginning of Aries togither with the howre index to the meridian, and then turned back the whole ſphære till the index come to 8 of the clock vpon the howre circle: you ſhall finde the aſcendent at that time, to be the 27 degree of Taurus; the mideſt or hart of heauen, the 27 of Capricorne: the deſcendent, the 27 deg. of Scorpio; and the loweſt part of heauen, the 27 deg. of Cancer.

To finde out the bredth of any climate; that is, how much the pole muſt be eleuated, or depreſſed, to make the longeſt day half an howre longer or ſhorter.

Prob. 37.

Lift vp, or put downe the pole of the Sphære, til you finde that there are 7 deg. and an halfe of the tropick of Cancer, more or leſſe aboue the horizon, then there were before: and mark withal how much the pole of the ſphære is rayſed, or let fall in the meane time, more then it was before; for ſo much is the bredth of that climate.

As for example: hauing ſet the ſphære to our latitude of London of 51. deg. and an halfe, with the point of your compaſſes, houlding and guiding ſome point of the tropick of Cancer right vnder the horizon; then liſting vp the pole till you finde 7. degrees and an halfe more aboue the horizon then were before, you ſhal finde the pole eleuated about 2 deg. and an halfe more then it was before.

Likewiſe, if you put downe the pole till there be 7 degrees and an halfe of the tropicke of Cancer, fewer aboue the horizon then was before; you ſhal finde the eleuation of the pole to be about 3 degrees leſſe then before.

The reaſon of the inæqualitie of naturall-dayes; that is, why the ſpace of 24 howres, is longer at one time of the yeare then at another time.

PROP. 32.

THe reaſon hereof is ſhewed partly by the inæqualitie of the differences of right aſcenſions aunſwerable to æqual arcks of the zodiacke, and partly by the vnæqual apparent motion of the ſun. For the firſt: the differences of right aſcenſions anſwerable to the parts of the ecliptick, about the tropicall points of Cancer and Capricorne, are much greater then about the æquinoctial points of Aries and Libra.

John Parkinson of London Apothecar

And Surgeon Doctor

In ſo much that whereas the difference of right aſcenſion aunſwerable to one ſigne, or 30 degrees taken about thoſe tropicall points, is more then 32 deg. and an halfe: about the æquinoctial points it is little more then 27 deg. and an halfe; as it may appeare by the Sphære. So as you may hereby gather, that the difference of aſcenſion anſwerable to one degree, which about the beginning of Capricorne is one deg. and about ſix minutes; about the beginning of Aries, or Libra, is only 55 minutes. Secondly the apparent motion of the ſunne is much ſwifter about his *Perigæum*, in the ſigne of Capricorne, then about his *Apogæum* in Cancer, or in other parts of the zodiack: ſo that whereas the ſun being in Capricorne moueth 61 minutes and ſomething more in a day: in Aries or Libra he moueth but 59 minutes or very little more in the ſame time. Therefore ſeeing the natural day is nothing els, but the time wherein the ſunne moueth from the Meridian about, til it returne againe to the ſame part of the meridian; it muſt needes be that alwayes in one natural day, there is made one whole reuolution of the æquinoctial circle, and ſo much more as is the difference of right aſcenſion aunſwerable to the apparent motion of the ſunne in the meane time; which differences of aſcenſion becauſe they be vnæquall, for the two cauſes before alleaged; the natural dayes muſt needs alſo be vnæquall, the motion of the æquinoctiall circle about his owne center being (as it hath beene alwayes ſuppoſed to be) æqual, that is mouing alwayes an æquall ſpace in æqual time.

Which by this example may moſt playnely appeare: The Sunne being in Capricorne moueth 61. minutes in a natural day: the difference of aſcenſion agreable thereto is 67. minutes, or ſomthing more. Therefore at that time, in the ſpace of one natural day, the æquinoctiall circle muſt make one full reuolution, and 67 minutes more. But when the ſun is in Aries, mouing onely 59 minutes in a day, and the difference of right aſcenſion aunſwerable thereto, ſcarce 54 minutes more then one reuolution of the æquinoctiall circle; there ſhal paſſe onely 54 minutes more in a natural day; ſo as here the æquinoctiall circle moueth not about ſo much in one day as before by 13. minutes. Seeing then that 15. degrees or little more of the æquinoctial circle doe paſſe the meridian in euery howre, & conſequently one degree of the æquinoctiall paſſeth the Meridian in fowre minutes of an howre, and one minute of a degree in fowre ſeconds of an howre; therefore 13 minutes of the æquinoctiall ſhall paſſe the meridian in 52 ſeconds: that is almoſt in one minute of an howre: Whereby it manifeſtly appeareth that the natural day, that is to ſay the ſpace of 24 howres, which is the time wherein the ſunne moueth from the noone-ſtead to the ſame noone-ſtead againe, is in our age greater almoſt by one minute of an howre, when the ſunne is in Capricorne, then when he is in Aries or Libra.

To finde by the Sphære how much the naturall dayes are longer at one time of the yeare then at another.

PROP. 33.

FOr this purpoſe it will be beſt to take a good number of dayes togither; as for example, take the whole moneth of December, and the whole moneth of March: both which moneths conſiſt of the ſame number of 31 natural dayes: finde the place of the ſunne for the beginning, and ending of both moneths, which you may finde by the ſecond propoſition to be for the beginning of March this preſent yeare 1600, about 20 degrees and thirteen minutes of Piſces; and for the ending about 20. degr. 48 minutes of Aries: Alſo for the beginning of December the ſame yeare 18 deg. 46 minutes of Sagittarie; and for the ending, twenty degrees 24. minutes of Capricorne: Then ſeeke out the right aſcenſions of the ſame places of the ſunne for the beginnings and endings of both thoſe moneths by the 4 propoſition, and the differences of aſcenſion aunſwerable to the motion of the ſunne in each moneth, by the ſixt propoſition; which you may finde by the Sphære to be about 33 degrees, 24 minutes for December, and 28 degrees 39 minutes for March. Laſtly finde out the difference of theſe differences of aſcenſion by ſubtracting the leſſer out of the greater; which in this exāple is 4 degrees 45 minutes; which reſolued into minutes of an howre, by taking for euery degree 4 minutes of an howre, and for euery fifteen minutes of a degree, one minute of an howre; ſhall amount to 19 minutes of an howre, that is a quarter of an howre and fower minutes. And ſo much is the moneth of December longer then the moneth of March; Notwithſtanding both of them conſiſt of the ſame number of 31 naturall dayes.

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The third Part.

Of the Orbes wherof the Sphæres of the Sunne and Moone haue been imagined to be made, and of theyr motions & vſes.

Of the Orbes whereof the Sphære of the ſunne is made.

Chap. 1.

WITHIN the Sphære or Orbe contayning all the circles that we haue hetherto ſpoken of, and repreſenting vnto vs the *Primum mobile*; that is, the firſt & higheſt moueable heauen, that hath beene imagined by the Aſtronomers, to ſhew the reaſon of that dayly motion, which appeareth to be in all the heauens; and of all the apparences that follow therevpon, are included the ſphæres & Orbes of the ſunne and moone.

The ſphære of the ſun conteyneth three orbes: The vppermoſt of them (which in this Sphære is ſignified by the yealow circle that commeth next within the compaſſe of the zodiack) is called *Deferens apogæum Solis*; that is, the Orbe which carieth about that point, wherein the ſunne is furtheſt diſtant from the earth.

Next within this Orbe is placed the eccentricke carying about the body of the Sunne; which in this Sphære is repreſented by the grene coloured circle that commeth next vnder the *Deferens Apogæum*.

Againe, within this Eccentrick is included the third Orbe of the Sphære of the ſun called *Deferens Perigæum Solis*; that is, the Orbe carying about that point wherein the ſunne is neareſt to the earth. This is the nethermoſt of the three Orbes of the ſunne, and in this ſphære is repreſented vnto you by the yealow coloured circle next vnder the ſunnes Eccentrick.

Of the vppermoſt and nethermoſt Orbes of the Sphære of the Sunne, more particularly.

Chap. 2.

IN the vppermoſt and nethermoſt of theſe three Orbes, there be 4 points eſpecially to be conſidered: That is, the points where they be narroweſt and where they be broadeſt, and where they are of a meane bredth betwixt the narroweſt and broadeſt. For at the narroweſt part of the vppermoſt Orbe where you may ſee written *Aux ſolis*, and the broadeſt part of the nethermoſt Orbe, is the place of the ſunnes *Apogæum*; ſo that whenſoeuer the ſunne commeth there, he is furtheſt diſtant from the earth. As you may eaſely trye, if (with a payre of compaſſes, or otherwyſe) you take the diſtance betwixt the earth and the ſunne being brought about to that place, and compare the ſame with the diſtances that the ſunne hath from the earth in other places. This point is called *Aux Solis*, and *longitudo longior*, that is, the point of the ſunnes furtheſt diſtaunce from the earth. But vnder the broadeſt part of the vppermoſt and vttermoſt Orbe, where you ſee printed *PERIGAEVM*, and right aboue the narroweſt part of the nethermoſt Orbe, is the place where the ſun commeth neereſt to the earth, as you may eaſely finde (with your compaſſes, or otherwyſe) in like ſort as before was ſhewed. The point where the ſun commeth neareſt to the earth, is called *oppoſitum Augis*, and *longitudo propior*, that is, the point oppoſite to the *Apogæum*, and the neareſt diſtance. And at thoſe parts of this Orbe, which are in the middeſt betweene the former; the ſunne hath a meane diſtance from the earth: a meane (I ſay) betweene the leaſt, and greateſt diſtance. The very point wherein this meane or middle diſtance hapneth, is ſhewed by the points that are iuſt in the midſt betweene the ſhort lines A B, and I K, which are drawne ouerthwart on eyther ſide of this Orbe. Theſe points are called *longitudines mediæ*; that is, the meane diſtances of the ſunne, becauſe the ſunn comming to theſe points, hath a meane diſtaunce be-

betweene the leaſt and the greateſt. About theſe points alſo, the true motion of the ſunne, is as it were in a meane betweene the ſloweſt, which hapneth the ſunne being about the *Apogæum*, and the ſwifteſt, which hapneth about his *Perigæum*.

Moreouer the lines A, and K, ſhew the places wherein there is the greateſt *Proſthaph æreſis*, or æquation of the ſun: that is, the greateſt difference betweene the true, and middle, or meane place of the ſunne.

Laſtly the diſtaunce betweene the lines I, and K, or A & B, ſhew how much the eccentricitie of the ſunnes eccentrick is, that is how farre the center of the eccentrick, is diſtant from the center of earth.

To finde how much the ſunne is nearer or further from the earth, at one time then at another.

CHAP. 3.

BY meanes of this circle, you may eaſily finde with your compaſſes, how much the ſunne is nearer to, or further from the earth at one time, the at another: for hauing ſet one foot of the compaſſes vpon the vtmoſt edge of the *Deferens Apogæum*, vnder the place of the ſunne in the zodiack, found by the ſecond propoſ ſtretch out the other foote, to the innermoſt edge of the ſame Orbe; for then, if you ſet one foote of your compaſſes, vpon the vtmoſt edge of this Orbe, at the *Apogæum*, the other foote turned inwards, towards the center of the

Sphære, will ſhew you how much the ſunne is nearer to the earth, at that time, then when he is in his *Apogæum*: for ſo much as that foote reacheth within the inner edge of the Orbe, ſo much is the ſunne nearer. Likewiſe if you ſet one foot of your compaſſes, vpon the vttermoſt edge of this orbe, at the *Perigæum*, and turne the other foote towardes the center of the ſphære, ſo much as this foote of the compaſſe, is from the inner edge of the *Deferens Perigæum*, ſo much is the ſunne further diſtant from the earth, at that time, then when he is in his *Perigæum*.

Of the ſituation and motion of the vppermoſt, and nethermoſt Orbes of the Sunne.

CHAP. 4.

THe vppermoſt, and nethermoſt of theſe three Orbes, called *Deferens Apogæum*, and *Perigæum ſolis*, do alwayes anſwere each to other, in ſuch ſort that the broadeſt part of the one, is alwayes againſt the narroweſt part of the other: And therefore both of them are moued togither, with one motion about the axtree and poles of the eclipticke, making one reuolution vnder the zodiack, in the ſpace of 17000. yeares almoſt. For in *Ptolemee* his time (that is about the yeare of our Lord 134.) the place of the Sunnes *Apogæum*, was about the middeſt of the 6 deg. of *Gemini*, as it may appeare by the 4. Chapter of the 3. booke of his Almageſt. But in our time we finde that it cannot excede the 7 degr. of *Cancer*, although after the account of *Copernicus*, &

of the Prutenicke tables, it ſhould be in the 9 degr. of *Cancer*. So as, if the reſt of the motion of the ſunnes *Apogæum*, that is to come hereafter, be proportionable to that is paſt, the whole reuolution thereof ſhalbe finiſhed in 16990. yeares vnder the zodiack. For in 1463. yeares betwixt *Ptolemee* his time and ours, it hath moued about 31 degr. therefore it ſhall moue 360. degr. (that is, the compaſſe of the whole circle) in 16990. yeares.

Which number of yeares being deuided by 360. it ſhall appeare that the *Apogæum* of the ſunne moueth one degr. in little more then 47 yeares, wherby the yearely motion thereof may be found to be little more then one minute and a quarter.

How to finde the place of the ſunnes Aux *or* Apogæum: *and of the vſes of the two foreſaid Orbes of the Sunne.*

CHAP. 5.

THerefore the place of the ſunnes *Apogæum*, being founde for the yeare 1600, to be about 7 degr. in *Cancer*, the place thereof for any other yeare before or after, may eaſely be found in our age, onely by ſubtracting, or adding for euery fowre yeares 5 minutes, & for euery ſingle yeare 1 minute and a quarter, Although indede we neede not ſtand ſo præciſely neyther vpon quarters of minutes, neither yet vpon whole minutes, in the place of the ſunnes *Apogæum*, which cannot be by any art ſo exactly found, but that the diligenteſt man that is, may erre many minutes therein.

Take for example the yeare of our Lord 1558. (in which our gracious Queene *Elizabeth* beganne her happie reigne, which is now 42. yeares ſince) taking therefore for euery 4 yeares 5 minutes, that is for 40. yeares 50 minutes, and for the two years remayning 2 minutes and one halfe; that is in all 52. minutes and an halfe, and ſubtracting the ſame out of 7 deg. of *Cancer*, there ſhall remaine the place of the ſunnes *Apogæum* at the beginning of her Ma^ties^. reigne, in 6. degr. and about 8 min. of *Cancer*.

The vſes of theſe two Orbes are theſe.

1. Firſt to make the ſphære of the ſunne concentricall; for theſe Orbes be ſo framed togither, that the narroweſt part of the one, aunſwereth alwayes to the broadeſt part of the other: it commeth to paſſe by this meanes, that both the out-ſide, and in-ſide of the Sphære of the ſunne, haue alwayes the ſame center, that the world it ſelf hath.

2. The ſecond vſe is to ſhew the reaſon, and manner of the motion of the ſunnes *Apogæum* and *Perigæum*.

Of the eccentrick of the Sunne, and how it hath beene proued that the Sunne is moued in an eccentrical Orbe.

CHAP. 6.

THe Orbe conteyned betweene the two former, and carying about the body of the ſun it ſelfe, is called the eccentricke of the ſunne; becauſe it hath another center, then the center of the world.

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The eſpeciall reaſon, that moued the skilfull in this cæleſtial ſcience, to make this Orbe (wherein the body of the ſunne is carryed) eccentrical; was becauſe they found the apparent motion of the ſunne vnder the eclipt ick line to be vnæquall, that is ſwifter in the ſoutherly ſignes: and ſlower in the northerly.

For *Hipparchus*, and *Ptolemee* found in their times, that the ſunne continued in the Northerne ſemicircle of the eclipt ick, from *Aries* to *Libra*, 187. dayes: and in the other half of the zodiack, that is Southward from *Libra* to *Aries*, 178. dayes and a quarter onely. But in our time by diligent obſeruation it is found, that the time of the ſunnes continuance in the firſt of thoſe ſemicircles from *Aries* to *Libra*, is 186 dayes 14 howres and an half: and conſequently in the other ſemicircle, from *Libra* to *Aries*, 178 dayes 15 howres and an half. Taking it therefore for a ground, according to the doctrine of *Ariſtotle*, that the motion of the cæleſtiall bodies is circular and æqual; it muſt needs follow, that a greater part of the circle deſcribed by the proper motion of the ſunne, muſt be conteyned vnder the northerly ſemicircle of the eclipt ick, then vnder the Southerly: and conſequently that the circle or orbe that caryeth about the body of the ſunne vnder the eclipt ick, hath another center then the center of the eclipt ick.

2. An other reaſon to proue that the ſunne is caried in an accentricall circle, is the vnæquall apparent bignes of the ſunnes diameter, the Sunne being of the ſame height aboue the horizon & the

ayre alike affected, and alike cleare; ſo as if there were any refraction by reaſon of the thicknes of the ayre, it muſt needs be the ſame in both places. For in ſommer, when the ſunne is at, or neare his *Apogæum*, his apparent diameter hath beene found by exquiſit obſeruation to be 13 minutes 48 ſecōds. But in winter being about his *Perigæum* 33. min. 54. ſeconds, as it may appeare in *Copernicus* his reuolutions 4 booke 21 Chapter.

Therefore ſeeing euery viſible obiect appeareth greater when it is neare, and leſſe when it is further remoued from vs, it is manifeſt that the ſunne appearing greater in winter, then in ſummer, muſt needes be nearer to the earth in winter, then in ſommer.

The reaſon of which apparaunce is moſt eaſely ſhewed, by ſuppoſing the ſunne to be moued, in an eccentricall Orbe.

3. A third reaſon may be the vnæquall greatneſſe and continuance of the eclipſes of the moone, euen at thoſe times when ſhe hath had the ſame latitude, or diſtaunce from the ecliptick, and the ſame diſtance from the center of the earth: which argueth that the conicall ſharp pointed ſhadow of the earth, in the place where the moone in time of the eclipſe paſſeth through that ſhadow, at the ſame diſtance from the earth, is ſometimes greater, and ſomtimes leſſer: whereof ther cā no cauſe be ſhewed more reaſonable then this, that the ſunne is ſometimes further diſtant from the earth, and then maketh the ſhadow greater, and ſometimes nearer, & ſo maketh it leſſer. Whereby it is alſo manifeſtly

proued; that the ſun is moued about another center then the center of the earth, and therefor that the circle or Orbe, wherein the ſunne is moued, is an Eccentricke.

Of the vſes of the Sunnes eccentricall Orbe.

Chap. 7.

THerefore the vſes of the ſunnes eccentrick may be theſe:

1. First to ſhew the reaſon of that apparent inæqualitie, which ſeemeth to be in the motion of the ſunne: for although the ſunne moue æqually in his owne Orbe, and about his owne center; yet to them that are at the center of the world, or vpon the earth, he ſhall ſeeme to moue vnæqually; that is, ſwiftly when he is in that part of his eccentricke which is neareſt vnto the earth; and ſlowly when he is fartheſt from the earth. And therefore in ſommer, when the ſunne is about his *Apogæum*, and in his greateſt diſtaunce from the earth, he ſeemeth to moue little aboue 57 minutes in one day. But in winter, being about his *Perigæum*, and neareſt vnto the earth, he ſeemeth to moue more then 61 minutes: whereas notwithſtanding he moueth æqually in his Eccentrick, euery day about nine and fifty minutes and 8 ſeconds; and ſo finiſheth his reuolution in 365. dayes, and ſix howres almoſt.

2. The ſecond vſe of the ſunnes Excentricke, may be to ſhew the reaſon why the ſun appeareth greater at one time then at another; for the ſunne being in thoſe parts of the eccentrick that are neareſt vnto vs, ſeemeth greateſt; & when he is in thoſe

parts of his eccentrick that are furtheſt from vs, he appeareth to be leaſt.

3. And laſtly the inæquality of the ſunnes diſtaunce from the earth, cauſed by his eccentrick, is one eſpeciall cauſe of the inæqualitie of the Eclipſes, both of the ſunne and Moone.

The definitions of certaine Aſtronomical wordes of art, for the better vnderſtanding of the Theorick of the ſunne.

CHAP. 8.

1. WHat the *Aux* or *Apogæum* of the ſunne is, it hath beene partly ſhewed already: that namely it is that part, or rather point of the Orbe carying the ſunnes *Apogæum*, wherein the ſaid Orbe is thinneſt, or narroweſt; Or it is that point of the eccentrick which is furtheſt diſtant from the earth, and is alwayes ſhewed by a right line vnderſtood to be drawn from the center of the world, by the center of the eccentrick, vnto the Orbe carying the ſunnes *Apogæum*. Which line is therefore called the line of the ſun his *Aux* or the line of the ſunnes *Apogæum*.

2. The motion of the *Aux*, or of the *Apogæum* of the ſunne (which is alſo called the ſunnes *Aux* in the ſecond ſignification) is nothing els but the arch of the Ecliptick, conteyned betwene the beginning of Aries, and the line of the ſuns *Apogæum*, drawne forth to the zodiack; where this line alſo ſheweth the place of the ſunnes *Apogæum*.

3. The middle or meane place of the ſunne in

the zodiack, is ſhewed by a line drawne from the center of the world vnto the zodiack, æquidiſtant from the center of the Eccentricke, and of the ſunne.

4 This line is therefore called the line of the meane or middle place of the ſun.

5 The middle or meane motion of the ſunne is the arch of the ecliptick betweene the beginning of Aries, and the middle place of the ſun.

6 The true place of the ſunne is ſhewed by a ſtreight line drawne from the center of the earth by the center of the ſunne vnto the zodiack, which line is therefor called the line of the true place of the ſun.

7 The true motion of the ſun is the arke of the eclipticke from the beginning of Aries, vnto the true place of the ſun.

8. The argument of the ſun (as the *Alphenſines* terme it) or the motion of the Sunnes Anomalie, (as *Copernicus* calleth it) is the arke of the ecliptick conteyned betweene the place of the ſunnes *Apogæum* and the middle place of the ſunne according to the order and ſucceſſion of the ſignes. This arch is called the argument, or motion of the ſunnes Anomalie, or irregularitie, becauſe that by it is alwayes found how much the ſuns true motion which (is vnæqual & irregular) differeth from his middle motion; which difference they call the ſuns æquation, or proſtaphæreſis.

9 The æqnation, or proſthaphæreſis of the ſun is nothing els but the arch of the ecliptick conteyned betwene the true, & middle places of the ſun.

This

Edward Hare his Book January ye 5 1733

Richard Hare his Book January ye 5 1733

This arch is called the ſunnes æquation, becauſe it maketh the ſuns middle motion æqual to his true motion, being added to it or ſubtracted from it, as occaſion requireth: for which cauſe it is more ſignificantly and fitly called *Proſthaphareſis*, that is as much to ſay, as that which is to be added to or ſubtracted from the middle motion, that ſo we might haue the true motion. For ſo long as the ſunne is in the ſemicircle of his excentrick, deſcending from his *Apogæum* to his *Perigæum*, ſo long this *Proſthaphereſis* is to be ſubtracted from the midle motion: but the ſunne being in the other halfe of his eccentrick aſcending, the *Proſthaphereſis* or æquation of the ſun muſt be added to the middle motion, that ſo the true motion and place of the ſunne may be found. Becauſe that in the firſt ſemicircle of the eccentricke deſcending, the middle place of the ſunne goeth before the true place, and the middle motion is allwayes greater then the true motion of the ſun; and therefore the difference of theſe two motions, (that is to ſay, the æquation or *Proſthaphereſis*) muſt be ſubtracted, to finde the true motion.

But in the other halfe aſcending, it falleth out contrarywiſe; for the true place of the ſunne goeth alwaies before the middle place, and ſo the true motion is greater then the middle motion, and therefore the æquation muſt be added to the middle motion for the finding out of the true motion and place of the ſame.

Of the vppermoſt Orbe of the Sphære of the moone, carying the Dragons head and tayle.

CHAP. 9.

NExt within the Orbes of the ſun in this Sphære are conteyned the Orbes of the Sphære of the moone: which are fiue in number.

The vppermoſt of them (which in this Sphære is next vnder the Orbe that caryeth the Sunnes *Perigæum* and is coloured with red) is called the Caryer of the Dragons head and tayle, or *Deferens nodos*, which is as much to ſay as the Caryer of the knots, that is of the two interſections, or pointes wherein the reſt of the Orbes of the Moone, doe croſſe ouer-thwart this Orbe. This Orbe is deuided into fowre ninetyes of degrees, for the eaſier reckoning of the motion & place of the dragons head or tayle in this ſphære. And it is moued about in 18 Iulian yeares 224 dayes 3 howres and 5 minutes almoſt, from the Eaſt Weſt-wards, vnder the Eclipticke. By reaſon of this motion it commeth to paſſe, that the eclipſes, or rather the places wherein the eclipſes of the ſunne or moone do happen in the heauens, are remoued continually, more backwards in the zodiack, contrary to the order and ſucceſſion of the ſignes.

As for example; the eclipſe of the moone hapning this preſent yeare 1600. the 20 of Ianuarie neare vnto the Dragons tayle about the 9 degree & 40 minutes of *Leo*; the next eclipſe that ſhall happen neare the ſame interſection of the dragõs tayle, in the yeare 1601, the 29 of Nouember, ſhall be in 17 degr. and an half of *Gemini*: And that eclipſe which ſhal be the next yeare after neare the ſame interſection the 19 of Nouember in the morning, ſhal be about the 6. degree and 40 minutes of Gemini &c.

Al this remouing of the eclipſes backwards cōmeth to paſſe, by reaſon of the motion of this Orbe carying the dragons head and tayle, contrary to the courſe and order of the ſignes.

The ſcituation of the Orbe carying the Dragons head and tayle.

This Orbe continueth alwayes right vnder, & euen with the Orbes of the ſphære of the ſunne: which abide alwayes in al parts iuſt vnder the ecliptick line, and hath his center agreeing, and all one with the center of the world, and of the ecliptick: And therefore the poles and axtree, about which this orbe is turned, agree iuſtly with the axtree of the Ecliptick.

The ſcituation of the reſt of the Orbes.

The reſt of the Orbes of the moone, that are conteyned within this, haue all theyr playnes agreeing in one, and lying euen one with another. But the one halfe of all their playnes, ariſeth aboue the playne of the former orbe, and of the Ecliptick, towards the North pole of the zodiack: and the other half deſcendeth beneath the playne of the ecliptick, toward the South pole: euen as the one half of the zodiack ariſeth aboue the æquinoctiall circle towards the North: and the other halfe deſcendeth towards the ſouth. And as the angle of interſection, or obliquitie of the ecliptick with the æquinoctiall circle, is 23 degr. and an half or little more: ſo the angle of interſection, or obliquity of the playnes of theſe Orbes of the moone, from the plaine of the Ecliptick, and of the former Orbe carying the Dragons head and tayle, is 5. degrees, or (according to *Tigho Brahe* his obſeruation) 5 degr. and a quarter almoſt ſometimes, & ſometimes leſſe then 5 degr.

That point or interſection of theſe Orbs with the former, from which they begin to ariſe about the playne of the ecliptick towards the North, proceeding Eaſt-wards, is called the Dragons head; and is ſignified by this character ☊: and the other point or interſection diametrally oppoſite vnto this, is called the Dragons tayle, which is alſo ſignified by the former character turned vpſide downe after this manner, ☋.

The two points of theſe orbes that are furtheſt diſtant from the plaine of the ecliptick, are called the bounds or limites of the moones latitude, and they are 90 deg. from the dragons head & tayle, & 5 deg. & a quarter almoſt from the playne of the Ecliptick, according to the obliquity, or greateſt declination of the plaines of theſe orbes, frō the playn of the ecliptick: Of theſe two points, that which is in the north ſide of the ecliptick, is called the north limit, or bound of the moones latitude; and contrariwiſe, the other point oppoſit to this on the ſouth ſide of the Ecliptick, is called the South limite of the moones latitude. And when the moone commeth to eyther of theſe two points, ſhe hath hir greateſt latitude.

Of the Orbes carying the moones Apogæum *and* Perigæum.

CHAP. 10.

NExt within the orbe carying the dragons head and tayle, is contayned the orbe called *Deferens Apogæum lunæ* which is the point wherein the moon is furtheſt diſtant from the earth.

And vnder this orbe is placed the moones Eccentrick, which is alſo called *Deferens epiciclum Lunæ*, that is the orbe carying the moones Epicycle.

Againe within this eccentrick of the moone, is conteyned the leaſt and loweſt Orbe, of all that are in this Sphære, Which they call *Deferens Perigæum Lunæ*; that is, the orbe carying the moones *Perigæum*, which is the point wherein the moone commeth neareſt to the earth.

The vppermoſt and nethermoſt of theſe three orbes, that is to ſay, the orbes carying the moones *Apogæum* and *Perigæum* (both which orbes in this Sphære are coloured with blewe) are alwayes placed in ſuch ſort, that the narroweſt part of the one, is continually aunſwerable to the broadeſt part of the other; whereby it commeth to paſſe, that the ſphære of the moone is made concentricall, that is to ſay, to haue the ſame center with the world: which alſo is one eſpeciall vſe, why theſe orbes were deuided.

Another vſe of theſe Orbes, is to ſhew the reaſon of the motion of the moones *Apogæum* and *Perigæum*: Therefore both theſe orbes are moued togither with one motion æqually, about the center of the world, in the ſame time from the Eaſt Weſtwards, in the ſpace of 32 dayes 3 howres & 5 min. almoſt: So mouing in one day 11 deg. 12 min. and 1 third part almoſt. The axtree, about which theſe orbes are moued æqually, paſſeth through the center of the world and of the ecliptick: but the poles of theſe orbes differ from the poles of the Ecliptick and of the orbe carying the dragons head and tayle, by the ſpace of 5 degr. and a quarter, or thereabouts which poles are caryed about the pols of the orbe carying the Dragons head and tayle, with the motion of the ſame orbe, in the ſpace of 19 yeares almoſt.

Whereby it commeth to paſſe, that the poles of the orbe carying the *Apogæum* and *Perigæum* of the moone, deſcribe certaine little circles about the poles of the Orbe that caryeth the Dragons head and tayle, euen as the Arcticke, and Antarcticke circle in the ordinary ſphære, are deſcribed by the motion of the poles of the Eclipticke, caryed about daylie with the motion of the firſt and higheſt moueable ſphære, in the ſpace of fowre & twenty howres almoſt.

Of the eccentrick of the moone.

CHAP. II.

THe Eccentrick of the moone conteyned betweene the two former orbes, and coloured with a ſad yealow colour in this ſphære, is moued æqually about the center of the ſame orbes, from the West towards the East, finiſhing his motion vnder the zodiack, in the ſpace of 27 dayes. and 8. howres almoſt: and with this motion, it carieth about the moones Epicycle æqually, vnder the zodiack.

Therefore the motion of this orbe, about his owne center, muſt needes be vnæquall: that is to ſay, ſwifter in thoſe parts that are about the *Apogæum*, and ſlower in the lower parts about the *Perigæum*: Becauſe that greater arches of the eccentrick, do aunſwere to æqual arches of the zodiack about the *Apogæum*, then about the *Perigæum* of the Eccentrick.

The axtree about which this orbe is moued, is alwayes in all places æquidiſtant from the axtree of the orbe carying the *Apogæum* of the moone: & the poles of the axtree of the moones eccentricke, are faſtned in the orbe carying the moones *Apogæum*, æquidiſtantly from the poles of the ſame orbe: therfore theſe poles togither with the whole axtree of the eccentrick, are caryed and æqually moued about the poles and axtree of the orbe carying the *Apogæum* from the East, towards the West. With this motion therfore, the poles and center of the eccentrick, deſcribe certaine little circles of æqual bignes, about the poles, and center of the Orbe carying the *Apogæum*, from the East West-wards. And therfore alſo the *Apogæum* of the eccentrick, is moued about æqually, vnder the ecliptick, contrary to the order of the ſignes frō the East West-wards. Whereby it commeth to paſſe, that both the *Apogæum*, and center of the eccentrick, are ſometimes vnder the Ecliptick, that is, when they are vnder the Dragons head or tayle: but for the moſt part they are beſide the plaine of the Ecliptick, either towardes the North; or els towards the South.

Hereby alſo it appeareth, that the plaine of the Ecliptick doth not alwayes deuide the plaine of the eccentrick into æquall parts or halfs; but then onely, when the center and *Apogæum* of the Eccentrick, is right vnder the Dragons head or tayle; for then onely the playne of the ecliptick deuideth the playne of the Eccentrick, by the center thereof; and conſequently deuideth it præciſely into two halfes. Otherwyſe, if the *Apogæum* of the eccentrick, be not vnder the dragōs head or tayle, looke on which ſide of the plaine of the ecliptick the *Apogæum* is, for on the ſame ſide of the Ecliptick is the greater part of the eccentrick.

In what proportion the the moones eccentrick, and orbe, carying her Apogæum *are moued.*

CHAP. 12.

NOw the Eccentrick of the moone, & the orbe carying her *Apogæum*, are moued in ſuch ſort, that the middle place of the ſunne, is alwayes right in the midſt betweene the center of the Epicyle caried in the eccentrick, and the *Apogæum* of the Eccentrick; except it be when the center of the epicycle is in coniunction, or oppoſition to the middle place of the ſunne. For in euery middle coniunction and oppoſition of the ſunne and moone, the center of the epicycle, and the *Apogæum* of the eccentrick are vnited togither; But in the coniunction they are both conioyned with the middle place of the ſun; & in the oppoſition they are both togither oppoſite to the ſame. VVhereof it followeth, that in the firſt & laſt quarters of the moone, the center of hir epicycle is diametrally oppoſite to the *Apogæum* of her eccentrick.

Hereof it commeth to paſſe, that although the moone haue the ſame poſition in her epicycle at the time of the new and full moone, and of the firſt and laſt quarters; yet the æquation, or proſthaphæreſis of the moones Argument (as they call it) that is the difference betweene the true, and middle places of the moone, is alwayes greater in the firſt and laſt quarter, then in the full and new moone. Hereby likewyſe it appeareth that in the time conteyned betweene new moone and new moone (which they cal *menſem ſynodicũ*, that is the moneth coniunctional, or the time from coniunction to coniunction) the center of the epicycle maketh two complete reuolutions, vnder the orbe carying the *Apogæum* of the moones eccentrick.

And therefor in euery moneth, the center of the epicycle commeth twiſe to the *Apogæum* & twiſe to the *Perigæum* of the eccentrick, and ſo the monthly motion of the center of the Epicycle, deſcribeth an oual figure: the endes whereof are alwayes towards the place of the ful & new moone, & the ſides towards the places of the firſt & laſt quarter.

By this that hath beene ſpoken, it is alſo manifeſt, that if the middle motion of the ſunne be, ſubtracted

tracted out of the middle motion of the moone, there remaineth the middle motion of the moones longitude from the ſunne, and that if this longitude againe be doubled, you ſhall haue the motion of the center of the moones Epicycle from the *Apogæum* of her eccentrick; which motion they call the center of the moone.

Of the Epicycle of the moone, and how it is moued.

Chap. 13.

THe little orbe placed in the Eccentrick, is called the Epicycle of the moone, in the circumference whereof is alſo placed the bodye of the moone, repreſented by the round beade, ſet into the moones epicycle in this ſphære.

The plaine ſuperficies of this epicycle, agreeth euen with the plaine of the eccentrick (and the axtree about which it is moued) is perpendicular to the plaine of the eccentrick. This Epicycle is moued æqually from his middle *Apogæum*, about his owne center and axtree from the East VVest-wards, contrary to the motion of the eccentrick, carying forwards the body of the moone with this motion 13 deg. and almoſt 4 min. euery day, and finiſhing his reuolution in 29 dayes 13 howres and 19 minut. almoſt.

The middle *Apogæum* of the Epicycle is ſhewed by a right line, imagined to be drawne, from that point of the little circle (deſcribed by the motion of the center of the moones eccentrick) which is oppoſite to the center of the eccentrick, by the center of the epicycle vnto the vpper part of the Epicycle.

But the true *Apogæum* of the epicycle, is ſhewed by a right line, vnderſtood to be drawne from the center of the earth, by the center of the Epicycle, vnto the vppper part of the circumference therereof.

Why the moone ſeemeth ſometimes to moue ſwifter, ſometimes ſlower.

By the motion of this epicycle it may eaſely be conceyued why the moone ſeemeth to moue ſometimes ſwifter & ſometimes ſlower: For ſeeing that the vpper part of the Epicycle, moueth contrary to the motion of the eccentrick from the Eaſt Weſtwards, when the moone commeth in that part, ſhe muſt needs ſeeme to moue more ſlowely, to them that are at the center of the world.

But when the moone commeth in the nether part of the Epicycle, the eccentrick caryeth the epicycle, and the epicycle carieth the body of the moone both one way; that is, from the weſt Eaſtwards, and therefore at that time the moone ſeemeth to moue more ſwiftly. According as you may ſee in the Ephemerides, the diurne motion of the moone to be ſometimes little more then 11 degr. and ſometimes againe little leſſe then 15 deg. The true motion of the moone ſeemeth then to be ſwifter, when the moone is in the *Perigæum* of her Epicycle, and the epicycle in the *Perigæum* of the eccentrick; becauſe then ſhe is not onely caryed forwards the ſame way both by her epicycle and eccentrick, but ſhe is alſo at that time neareſt vnto vs:

for which cauſe her motion ſhall ſeeme ſwifter, then when the epicycle is in other parts of the Eccentrick.

The definitions of certaine aſtronomicall wordes of art, for the better vnderſtanding of the theorick of the Moone.

Chap. 14.

1. THe line of the moones middle motion, is a line vnderſtood to be drawne from the center of the earth, by the center of the moones Epicycle, vnto the zodiack.

2. This line ſheweth the middle place of the moone in the zodiack.

3. And the middle motion of the moone, is the arch of the zodiack, from the beginning of Aries, vnto the ſame line.

4. So likewiſe the line of the true motion, or of the true place of the moone, is drawne from the center of the world, by the center of the moone, to the zodiack.

5. This line therefore ſheweth the true place of the moone in the zodiack.

6. And the true motion of the moone, is the arch of the zodiack, from the beginning of Aries, vnto the true place of the moone.

7. The middle longitude of the moone from the Sunne, is the arch of the zodiack, from the middle place of the Sun eaſtwards vnto the middle place of moone.

8. And this arch doubled, is called the dou-

bled longitude of the moone from the Sunne, or the center of the Moone (as the *Alphonſines* cal it) which is nothing els but the arch of the zodiacke, betwene the place of the *Apogæum* of the eccentrick and the middle place of the moone. It is called the doubled longitude of the moone from the ſun, becauſe it is alwayes twice ſo much, as is the middle longitude of the Moone from the ſun.

9. And it is called the center of the moone, becauſe it ſheweth the diſtaunce of the center of the Moones Epicycle from the *Apogæum*.

10 The æqnation, or *Proſtaphæreſis* of the center, is the arch of the epicycle, betweene the middle & true *Apogæum* of the epicycle.

This æquation or *Proſthaphæreſis*, is nothing at all, when the center of the epicycle is in the *Apogæum*, or *Perigæum* of the eccentrick. But the epicycle being in any other part of the Eccentricke there is alwayes ſome æquation of the center; yea in ſome parts thereof, where it groweth greateſt, it is 13 deg. 9 minutes: and ſo long as the center of the epicycle, is in the half of the eccentrick deſcending from the *Apogæum* to the *Perigæum*, that æquation is to be added to the motion of the epicycle; but in the other halfe of the Eccentrick aſcending, it muſt be ſubtracted; that ſo the true Argument or Anomalie of the Epicycle may be had.

11 The Argument, or Anomalie of the Moone is nothing els, but the motion of the Moones Epicycle.

12. The true or middle argument, or Anomalye, is the arch of the Epicycle from the true or

middle *Apogæum* of the Epicycle, vnto the center of the body of the moon, reckoned that way, which the epicycle moueth.

13 The æquation of the argument, or *Proſthaphæreſis* of the epicycle, is the arch of the zodiack, betweene the middle, & true place of the Moone. This æquation is nothing, when the moone is in the true *Apogæum*, or *Perigæum* of her epicycle. But it is greateſt, when the center of the moone commeth to the line, drawne out of the center of the world, and touching the epicycle, when it is in the *Perigæum* of the eccentrick.

And the moone being in the firſt, that is in the Weſterly half of the Epicycle, counted from the true *Apogæum* therof, the middle place of the moon goeth before the true place, and the æquation of the argument muſt therefore be ſubtracted: but when the moone is in the other latter, and eaſterly ſemicircle of the Epicycle, the true place goeth before the middle place, & ſo that æquation muſt be added to the moones middle motion, that the true motion and place of the moone may be found.

The reaſon of the variety of the Moones æquation ſhewed by this ſphære.

CHAP. 15.

THis æquation becommeth leſſer or greater, according as the epicycle is further of, or nearer to the center of the world. The leaſt æquations are, when the epicycle is in the *Apogæum* of the eccentrick,

trick, & contrary wiſe, the greateſt muſt happen, the epicycle being in the *Perigæum* of the eccentrick.

The difference betweene theſe greateſt, & leaſt æquations, *Ptolemee* and *Copernicus* call the exceſſe: but *Purbachius*, and the *Alphonſines*, call it the diuerſitie of the diameter; becauſe that difference of the æquations, ariſeth by reaſon of the diuerſe apparent bigneſſe of the diameter of the Epicycle, according as it is nearer to vs, or further from vs.

Therefore in the Aſtronomicall tables, they vſe to ſet downe thoſe æquations only, which happen when the Epicycle is in the *Apogæum* of the eccentrick, which are the leaſt æquations, whereto they alſo adioyne the exceſſe, or diuerſity of diameter, ſhewing how much thoſe æquations, which happen when the Epicycle is in the *Perigæum* of the Eccentrick, exceede thoſe which happen, the epicycle being in the *Apogæum* of the eccentrick. Moreouer, there are annexed certaine min. which they call *Scrupula*, or *minuta proportionalia*: that is, proportionall minutes: whereby is found, how much of the ſayd exceſſe, is to be added to the foreſayd æquations, when the epicycle is in any other part of the eccentrick, then in the *Apogæum*: that ſo the true æquation of the argument, for the ſame part of the eccentrick might at any time be found. For then onely is that whole exceſſe to be added, when the epicycle is in the *Perigæum* of the eccentrick. But if the epicicle be in any other part of the eccentrick; then looke what proportion 60 hath to the whole exceſſe, the ſame proportion haue the proportionall minutes, anſwerable to the part of the centrick, wherein the epicycle is, vnto the part proportional of the exceſſe, which (part proportionall) being added to the æquation before found, ſhall giue you the true æquation.

The reaſon of the moones proportionall minutes ſhewed by this Sphære, and how to finde the ſame.

CHAP. 16.

THe reaſon of thoſe proportional minutes, may in ſome ſort be ſhewed, by thoſe concentricall arches of circles, which you ſee drawne vpon the moones eccentricall orbe, in this ſphære: but indeede all thoſe arches muſt be vnderſtood, to haue alwayes the ſame center with the world, and not to be moued about togither with the eccentrick. The vppermoſt of them is to be drawne by the center of the epicycle being in the *Apogæum* of the eccentrik, and the nethermoſt is drawne by the ſame center when it is in the *Perigæum* of the eccentrick: ſo as the diſtaunce of theſe two arches, or peripheryes, is iuſt twiſe ſo much as the eccentricitie; that is the diſtaunce of the center of the eccentrick, from the center of the world, ſhewed by the diſtaunce of the ſhort lines N O, or F F, vpon the orbe carying the *Apogæum*; or of P Q, or G H, vpon the caryer of the *Perigæum* of the moone.

The whole diſtance, betwene theſe two peripheryes, from the vttermoſt to the innermoſt, is vnderſtood to be deuided into 60 æqual parts, imagining euery one of theſe to conteyn 10: as may appeare by the figures ſet to euery one of them, from the vppermoſt

moſt to the nethermoſt, in this order: 10 20 30 40 50 60.

To finde the moones proportional minutes.

Now the interſections of theſe *Peripheries* with the eccentrick (that is, with the vppermoſt of the two deuided *peripheries*, which are drawne round about through the midſt of the moons eccentrical orbe) do ſhew what proportionable min. anſwere to any part of the eccentrick, after this manner: In the vppermoſt of the two foreſayd graduated *peripheries*, looke that diſtance of the center of the moones epicicle from the *Apogæum* of the eccentrick, (that is to ſay) that doubled longitude of the moone as the *Alphonſines* cal it) which you deſire: Then looke which of the concentricall arches before mentioned paſſeth by the terme, or end of that diſtāce, or doubled longitude: And thirdly, looke about in the ſame arch, what number is ſet therupon, for that ſheweth you the number of the proportionall minutes, aunſwereable to the ſituation of the epicicle, at that diſtaunce from the *Apogæum* of the eccentrick.

What the proportionall minutes of the moon are.

Theſe proportional min. therfore may be defined to be nothing els, but the ſixtyth parts of the diuerſitye of diameter, or of the exceſſe wherwith the æquations of the argument, or *proſthaphæreſes* of the Epicycle are to be augmented, when the epicyle is any other part of the Eccentrick, then in the *Apogæum*.

Otherwyſe alſo, theſe proportional min. may be defined, to be ſixtieth parts of the exceſſe, wherewith the line drawn from the center of the earth, to the *Apogæum* of the moones eccentrick, exceedeth the line drawne from the ſame center to the *Perigæum* of the eccentrick: For theſe ſixtieth parts alſo may not vnfitly be called proportional minutes, becauſe that alwayes, looke how many of theſe parts there are left without the circumference of the eccentrick, or beyond the center of the epicylcle; ſo many of the former ſixtyeth parts of the diuerſity of diameter, or of the exceſſe of the *proſtaphereſis* of the Epicycle, muſt be added to the æquation of the argument, that the true æquation of the argument may be had, for that poſition, or ſituation of the Epicycle, in the eccentrick.

The reaſon of the eclipſes of the ſunne and moone, ſhewed by this Sphære. Chap. 17.

NOw by this ſphære, it may eaſely be conceyued, why there is not an eclipſe, in euery coniunction or oppoſition of the ſun & moone. For ſeeing that the moone hath for the moſt part a greater apparent latitude, then the viſible or apparent conioyned ſemidiameters of the ſun & moone in the coniunction: & becauſe the true latitude of the moone, is alſo for the moſt part greater then the apparent ſemidiameters of the moone and ſhadow of the earth (at that place where the moone ſhould paſſe through that ſhadow) in the oppoſition, to make an eclipſe: it commeth to paſſe, that in moſt coniunctions & oppoſitions of the ſun & moone, there is no eclipſe. And the reaſon hereof is this, becauſe that the moone commeth vnder the way of the ſun (which we called the ecliptick line) onely twiſe in a moneth, and thoſe two points (wherein the wayes of the ſun & moon croſſe each other) only twiſe in a ſynodical month, which two points we called the dragons head & tayle; (wherof we haue alſo ſpoken before.) Wherfore, ſeeing the ſun (going but once onely through the compaſſe of the eliptick in a yeare) can come but once in a yeare to eyther of thoſe points; the moone for the moſt part, when ſhe commeth to be in oppoſition, or coniunction with the ſun, muſt needes be ſo farre wide from the ecliptick line, or way of the ſun, either towards the north or ſouth: that ſhe can neither come betwixt vs and the ſunne in the coniunction, nor yet within the compaſſe of the ſhadow of the earth in the oppoſition.

But when the ſun commeth neare eyther of thoſe points (which hapneth once in ſix months) there muſt needs for the moſt part be ſome eclipſe, eyther of the ſunne, or moone, or both.

Of the diuerſitie of the bounds, or ſpaces, within which an eclipſe may happen: and the reaſon of that diuerſitie. Chap. 18.

THe bounds or diſtaunces from the Dragons head or taile, within which there may happen an eclipſe of the moone, are ſometimes greater, aud ſometimes leſſe, by reaſon of the diuerſe diſtances of the ſunne, or moone, or both of them, from the earth. For ſeing the body of the ſun is greater then the globe of the whole earth (as it is manifeſtly demonſtrated by *Ptolemee* and *Copernicus*) it muſt needs be, that the greater diſtaunce the ſunne hath from the earth, the greater ſhadowe muſt the earth haue; and the nearer the ſunne is to the earth, the leſſe ſhadow ſhal the earth haue, at the place of the moones paſſage through the ſhadow, at æquall diſtances from the earth.

Contrariwyſe, the further that the moone is from the earth, the leſſe ſhall the ſhadow of the earth be, & the nearer the moon is to the earth, the greater ſhal the ſhadow be, at the place where the moone is to paſſe through the ſhadow.

The greateſt diſtaunce therefore from the dragons head or taile, wherin there can at any time happen any eclipſe of the moone, is about 13 degr. And the leaſt diſtaunce at which it is poſſible for the moon to auoid an eclipſe, is about 10 degr. and one third part of a degree; which hapneth when the moone is in the *Apogæum* of her epicycle, in her greateſt diſtaunce from the earth, and the ſun in his *Perigæum*, in the time of his greateſt eccentricity, for then the ſunne commeth neareſt to the earth and maketh the leaſt ſhadow: as contrariwiſe at the ſame time of his greateſt eccentricitie, being in his *Apogæum*, he hath his greateſt diſtance frō the earth, and ſo maketh the earth caſt forth hir greateſt ſhadow. At which time, if the moone alſo chance to be in the *Perigæum* of hir epicycle, and ſo in hir neareſt diſtance from the earth, ſhe may be ſomething eclipſed, although ſhe be full 13 deg or ſomthing more from the Dragons head or tayle.

How to finde the place of the Dragons head or tayle for any time. CHAP. 19.

NOw the place, and time of the full moone, being eaſely knowne, by ſome almanack, or Prognoſtication; it ſhall not be hard, to giue a reaſonable neare eſtimate, and to foretell both the time, and quantitye of the eclipſe of the moone, the place of the Dragons head & tayle, being firſt knowne after this manner.

The place of the dragons head, being firſt giuen for any time, for euery yeare before the ſame time, adde to the ſame place: & for euery yeare after the ſame time ſubtract 19 degr. & one third part of a deg. & for euery moneth a deg. & an half & a tenth part of a deg. & for euery day 3 min. & the remainder ſhall ſhew you the place of the dragons head after the ſame time: or the ſumme before that time, without any great errour.

As for example, the 30 of Iune this preſent yeare 1600, ſuppoſe you would know the place of the Dragons head: The place therefore of the Dragons head being firſt giuen, for the beginning of the ſame yeare, in 0 degr. 45 min, of *Aquarius*: and ſix moneths onely of that yeare being paſſed, I take for thoſe ſix moneths 6 deg. and 6 half deg. that is 9 deg. and ſix tenth parts of a deg. that is 36 min. the ſumme of al which is 9 deg, and 36 minutes.

Which being ſubtracted out of 0 deg, 45 min. of *Aquarius*, there remaine 21 deg. 9 min. of Capricorne, for the place of the Dragons head at that time.

A table for finding the place of the dragons head and taile more exactly and the declaration thereof.

CHAP. 20.

BVt if you would haue the place of the Dragons head more exactly, you may finde the ſame moſt eaſely, by meanes of the table following, for any time within the ſpace of theſe 20 yeares yet to come.

This table conteyneth 3 principal parts, or columnes the firſt part ſheweth you in what ſigne, degr. and min. the dragons head is, at the beginning of any yeare; frõ this preſent yeare 1600 till the yeare 1620. The ſecond part ſheweth, how much the Dragons head moueth, in any number of moneths of the yeare: the third part giueth you the motion of the dragons head, in any number of dayes of the moneth.

At the beginning of the yeares of our Lord.

The place of the Dragons head.									
Yeare	*Sign.*	*Deg.*	*Mi.*	*Moneths Complete.*	*Do.*	*Mi.*	*Day*	*De.*	*Mi.*
1600	*Aquarius*	0	45	*Ianuar.*	1.	38	1	0.	3
1601	*Capricorne*	11	21	*Februar.*	3.	8	2	0.	6
1602	*Sagittari.*	22	2	*March*	4.	46	3	0.	10
1603	*Sagittari.*	2	42	*April*	6.	22	4	0.	13
1604	*Scorpio*	13	22	*Maye*	8.	0	5	0.	16
1605	*Libra.*	23	59	*Iune*	9.	36	6	0.	19
1606	*Libra.*	4	39	*Iulie*	11,	14	7	0.	22
1607	*Virgo*	15	19	*Auguſt.*	12.	53	8	0.	25
1608	*Leo*	25	59	*Septemb.*	14	28	9	0.	29
1609	*Leo*	6	35	*October*	16.	7	10	0.	32
1610	*Cancer*	17	15	*Nouemb.*	17.	42	11	0.	35
1611	*Gemini*	27	55	*Decemb.*	19.	21	12	0.	38
1612	*Gemini*	8	35				13	0.	41
1613	*Taurus*	19	12				14	0.	44
1614	*Aries*	29	52				15	0.	48
1615	*Aries*	10	32				16	0.	51
1616	*Piſces.*	21	12				17	0.	54
1617	*Piſces*	1	49				18	0.	57
1618	*Aquarius*	12	29				19	1.	0
1619	*Capricor.*	23	9				20	1.	4
1620	*Capricor.*	3	49				21	1.	7
							22	1.	10
							23	1.	13
							24	1.	16
							25	1.	19
							26	1.	18
							27	1.	26
							28	1.	29
							29	1.	32
							30	1.	35

To finde

To finde the place of the Dragons head or tayle, by the former table.

Chap. 21.

FInde out in the former table, the moneth next going before the moneth giuen; finde out alſo the day of the moneth, Adde togither the numbers of degrees and minutes anſwerable to that moneth and day of the moneth, & ſubtract the ſame out of the place of the Dragons head at the beginning of the yeare, adding thereto 30 degr. (that is the whole ſigne next going before reſolued into degr.) if the ſunne aforeſayd be greater then the number of degr ſhewing the place of the dragons head at the beginning of the yeare: ſo ſhall you haue the place of the Dragons head for the time giuen. And the point of the zodiack oppoſite to this, is the place of the Dragons taile.

Take for example, the 29. of Nouember 1601. I finde therfore againſt October (the moneth going next before Nouember) 16 deg. 7 min. & againſt the 29 day 1 deg. 32 min. the ſumm of both theſe added togither is 17 deg. 39 min. The place of the dragons head for the beginning of the yeare 1601 is 11 deg. 21 min. of Capric. which becauſe they be leſſe then 17 deg. 39. min. I add vnto them 30 degr. that is the whole ſigne of Sagittarie, and the ſumme of both is 41 degrees 12 minutes, out of which ſubtract 17 degrees 39 minutes and there ſhal remaine 23 degrees 42 minutes of Sagittarie; the place of the dragons head at that time. And the point of the zodiack which is oppoſite hereto (that is the 23 deg. 42 min. of Gemini) is the place of the Dragons tayle.

To know at what time there ſhal be an eclipſe of the moone.

Chap. 22.

THe place of the dragons head being thus knowne, finde out the ſame place vpon the horizon of the ſphære, and ſee what day and moneth anſwereth thereto: finde out alſo the place of the full moone, which hapneth next before or after that day, which place if it chaunce to be within 11 or 12 degr. eyther before or after that point of the zodiack which is oppoſite to the dragons head, there muſt needes be for the moſt part an eclipſe of the moone.

Likewyſe if you finde what day and moneth is aunſwerable to the place of the dragons tayle vpon the horizon of the ſphære if the place of the full moone which happeneth next before or after that day chaunce to be within 11 or 12 degr. of the dragons head, for the moſt part there ſhall be an eclipſe of the moone.

As for example The 20 day of Ianuarie laſt this preſent yeare 1600 the place of the dragons head was fownd (by the former Chap.) to haue beene in 29 deg. 41 min. of Capricorne; where to there anſwereth in the horizon the 10 day of Ianuary the place of the full moone hapning next after, vpon the 20 of the ſame moneth in the morning muſt needs be in the place oppoſite to the place of the ſunne the ſame 20 day: Therefore becauſe the ſunne that day is in 9 degr. and about on half of Aquarius, therfore the place of the full moone ſhall be in 9 degr. and about one half of the ſigne oppoſite to Aquarius, that is of Leo; becauſe it is within leſſe then 11 degr. of the dragons tayle (for the dragons tayle is in the 29 deg. 41 min. of Cancer, that is in the place oppoſite to the dragons head, being in the 29 deg. 41 min. of Capricorne) therefore there was at that time an eclipſe of the moone: Alſo becauſe the place of the moone, the ſame day at noone, was about 12 degr. and one halfe of Leo; that is, about 3 deg. more then at the time of the ſul moone eclipſed; it may hereby appeare abating for euery deg. 2 howres, that the midſt of the eclipſe was about 6 of the clock in the morning.

* * *

FINIS.

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